Montana Department of
ENVIRONMENTAL QUALITY

Brian Schweitzer, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov

MAILED
4-20-09 gh

April 20, 2009

Mr. Gary Keeler, *Manager*
BUTTE-SILVER BOW LANDFILL
126 West Granite Street
Butte, MT 59701-9216

RE: **CLOSED BUTTE-SILVER BOW COUNTY LANDFILL – LICENSE #20**
BUTTE-SILVER BOW OLD LANDFILL FACILITY GROUNDWATER SAMPLING AND ANALYSIS PLAN (SAP), MARCH 13, 2009

Dear Mr. Keeler:

The Department has reviewed the updated Sampling and Analysis Plan for the closed Butte-Silver Bow County Class II Landfill, in Butte, MT. The Department approves the Sampling and Analysis Plan provided the following condition is met:

- Please include a column for water level in the Field Parameters table on the Field Sample Data Sheet. Regular measurements of water level are necessary to ensure proper application of the low-flow (minimal drawdown) sampling method described in this plan. An updated version of the Field Sample Data Sheet should be submitted to the Department for inclusion into the SAP.

If you have any questions or comments regarding this review, please do not hesitate to contact me directly at the Permitting and Compliance Division, Waste and Underground Tank Management Bureau, Solid Waste Program.

Sincerely,

Martin Van Oort
Environmental Science Specialist
Solid Waste Program
Phone: 406-444-2802, Fax: 406-444-1374
E-mail: mvanoort@mt.gov

File: Closed\Silver Bow Co.\Butte-Silver Bow Class II\License #20\Groundwater Monitoring
Path: G:\WUT\SWS\GWater\Responses\Silver Bow Co\2009-03_cl_bsb_20_SAP.doc
cc: Mr. Shawn Bisch, Pioneer Technical Services, PO Box 3445, Butte, MT 59702

Correspondence Slip

Project ID: -

Requested: 4/17/09

Needed By: 4/21/09

Originator: MVP

Org(s)/Mail Code:

REVIEW ROUTING

Name	Task	Initial/Date
Admin	Proof	Jh, 4/17
Mary H	Review	4/17
Darrell	Review	Das, 4/17
Rick	Review	RT, 4-17-09

Mail original via:
☒ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\ see letter

Special Instructions:

Please make a copy for the file of Lic. #262 & place the original in Lic. #360.

Mail copy of enclosures to CC's? Y [✓ N]

Copies of enclosures for file needed? Y [✓ N]

Copy of letter for file needed? [✓ Y] N

Silver
Bow-Co.

ROUTE SLI

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: Proof CJ

DATE: 1/28/94

1. Pat C.
2. Jon D. JD
3. Roger T.

☑ Approval
☐ Note and Return
☐ Prepare reply
☐ As requested
☐ Comment
☐ Note and File
☐ Signature
☐ For your information
☐ Necessary Action
☐ Investigate
☐ See Me
☐ Per Conversation

REMARKS:

sw\silbutt.req

mailed
1-31-94 lh

"blind" cc: to
Dave Erickson
SRM
P.O. Box 4168
Butte, MT 59702

FROM: 3

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
MARC RACICOT, GOVERNOR 406/444-1430
FAX # (406) 444-1499
STATE OF MONTANA
OFFICE LOCATION 836 Front Street Helena, Montana
MAILING ADDRESS: PO BOX 200901 Helena, MT 59620-0901

January 31, 1994

Jim Johnston, Director of Public Works
Department of Public Works
Butte-Silver Bow Courthouse
Butte, Montana 59701

RE: **BUTTE-SILVER BOW CLASS II LANDFILL, SILVER BOW COUNTY - LICENSE NO. 20**
SOIL BORING LITHOLOGY LOGS & MONITORING WELL COMPLETION FORMS

Dear Mr. Johnston:

It has come to the attention of the Department, during preparation for the Fall 1993 ground water sampling event at the old Butte-Silver Bow Class II Landfill, that lithologic logs from soil borings advanced at the site, as well as ground water monitoring well completion forms have not been submitted to the Department [see, Administrative Rules of Montana (ARM) 16.14.705(11)]. Normally, this data is incorporated into the Hydrogeologic and Soils Study/Report for each solid waste disposal facility that is required to monitor the quality of the ground water [see, ARM 16.14.703(1)]. These documents are also part of the requirements for an adequate, site-specific Sampling and Analysis Plan (SAP) which is also a requirement at each facility conducting ground water monitoring [ARM 16.14.706(1)].

The Department was in agreement with Butte-Silver Bow's contracted consulting firm, Special Resource Management (SRM) at the time the first phase of monitoring wells were installed that the soil boring/lithology logs and the monitoring well completion forms would all be submitted with the Hydrogeologic and Soils Study/Report which had been temporarily deferred until the second phase of monitoring well installations had been completed.

With several consulting firms apparently involved in work projects at this site, it is pertinent that all field and laboratory data be submitted to the Department on a very timely basis after the work has been completed. Therefore, the Department will require Butte-Silver Bow to submit copies of the above-requested data within 15 calendar-days from the date of this letter. Other documents

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that will be required to be submitted in a completed form during the first quarter of this year (1994) will be as follows:

> * Hydrogeologic and Soils Study/Report. There will be no further extensions given to attempt to make this an all inclusive hydrogeologic document for the site, as was originally intended.
>
> * Sampling and Analysis Plan. A site-specific SAP will be required before the Spring 1994 sampling event may commence. This should be scheduled in the early part of June 1994, and will probably be required under Assessment Monitoring conditions (i.e., Table II parameters/constituents).

If you have any questions, please give me a call.

Sincerely,

Pat Potts by ch

Pat Potts
Environmental Specialist

cc: Gary Keeler, Department of Public Works, Butte-Silver Bow, (as above)

Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, MT 59701

Dan Powers R.S., Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

path: sw\silbutt.req
file: silver bow county/old butte II landfill/grd wtr (corr)

Silver Bow

ROUTE SLI

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: Proof fA DATE: 7/8/93

1. Pat C PPC ✓
2. Jon D JD
3. Roger rcs

☑ Approval
☐ Note and Return
☐ Prepare reply
☐ As requested
☐ Comment
☐ Note and File
☐ Signature
☐ For your information
☐ Necessary Action
☐ Investigate
☐ See Me
☐ Per Conversation

REMARKS:

sw\ oldbutte.wel

mailed 7-9-93 lm

FROM: p^3

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
(406) 444-1430
MARC RACICOT, GOVERNOR
FAX # (406) 444-1499
STATE OF MONTANA
OFFICE LOCATION 836 Front Street
Helena, Montana
MAILING ADDRESS: PO BOX 200901
Helena, MT 59620-0901

July 8, 1993

David J. Erickson
Special Resource Management, Inc.
P.O. Box 4168
Butte, Montana 59702

RE: **BUTTE-SILVER BOW LANDFILL, SILVER BOW COUNTY - LICENSE NO.20**
APPROVAL FOR "B" SERIES GROUND WATER MONITORING WELLS.

Dear Mr. Erickson:

The letter dated June 29, 1993 with the "B" Series proposed well locations and ground water contour map for the old Butte-Silver Bow County Class II Landfill was very beneficial in presenting the initial characterization of the shallow (i.e. above bedrock) hydrogeology at this site. Your previous correspondence which included the ground water analytical results from sampling the "A" Series wells also helped give me sufficient information to begin to understand the nature of the possible leachate contaminant plume(s) emanating from the landfill. The lithologic boring information that you initially conveyed to me over the telephone was also essential in providing me with a better understanding of the site, so that I could make an informed evaluation of the "B" Series well proposal.

The Montana Department of Health and Environmental Sciences Solid Waste Program (the Department) approves the 4 "B" Series proposed well locations with only one comment, which we discussed over the telephone on July 7, 1993. This suggestion involved the Department's concern over the need to address the lateral extent (i.e. east-northeast) of the contaminant plume(s) detected in the ground water on the east side of the landfill. By moving the proposed location for BSB-B6 approximately 200 feet to the east, a more lateral distribution of the data points might be achieved. Field conditions may dictate the exact location for this well.

"AN EQUAL OPPORTUNITY EMPLOYER"

Thank you for the information on this site as it is becoming available. If you have any questions, give me a call.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, MT 59701

Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, MT 59701

Dan Powers, Paul Riley, Jon Rolich; Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

path: sw\oldbutte.wel
file: silverbow co/old butte/grd wtr

Butte-
Silver Bow

ROUTE SLIP

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: Proof JA DATE: 4/30/93

1. Pat C PC
2. Jon D JD
3. Roger/Duane for DLR

☑ Approval	☐ Comment	☐ Necessary Action
☐ Note and Return	☐ Note and File	☐ Investigate
☐ Prepare reply	☐ Signature	☐ See Me
☐ As requested	☐ For your information	☐ Per Conversation

REMARKS:

sw\butte.ph2

mailed
5-3-93
en

FROM: p3

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
(406) 444-1430
MARC RACICOT, GOVERNOR
FAX # (406) 444-1499
STATE OF MONTANA
OFFICE LOCATION 836 Front Street Helena, Montana
MAILING ADDRESS: PO BOX 200901 Helena, MT 59620-0901

April 30, 1993

David J. Erickson, Hydrogeologist
Special Resource Management, Inc.
P.O. Box 4168
Butte, Montana 59702

RE: **BUTTE-SILVER BOW CLASS II LANDFILL - LICENSE NO.20**
APPROVAL OF PHASE II OF THE HYDROGEOLOGIC AND SOILS STUDY.

Dear Mr. Erickson:

The submittal dated April 21, 1993 entitled "Initial Ground Water Monitoring Plan", for the above referenced facility has been approved by the Montana Department of Health and Environmental Sciences Solid Waste Program (the Department) for prompt implementation. As we discussed in our telephone conversation on April 29, 1993, possible confusion may arise over the title of this document, compared to the required Ground Water Monitoring Plan as referred to in the Administrative Rules of Montana (ARM) 16.14.708(1)(b). This document submittal shall be referred to in the future as **"Phase II of the Hydrogeologic and Soils Study"** according to the requirements set forth in ARM 16.14.703(1)(a)(xiii).

We also discussed the following general comments concerning the document as submitted, and are included below for your reference:

1.1 Sample Collection - Item #2.
Consider using the electronic probe to detect and measure the thickness of any dense non-aqueous phase liquids (DNAPLs), if present.

1.2 Chain-of-Custody - Item #3.
Include under the "Static Water Level" bullet:
recording the thickness of any LNAPLs, or DNAPLs detected during measurement of the ground water levels.

The Department appreciates SRM's efforts to keep us informed as work progresses at the site toward the final Hydrogeologic and

Soils Study/Report (due July 12, 1993), and the scheduled ground water monitoring program for this facility.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, Montana 59701

Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, Montana 59701

Dan Powers, Paul Riley, Jon Rolich, R.S.s, Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

path: sw\butte.ph2
file: silverbowco/OLD butte/grd wtr

Butte-Silver Bow

ROUTE SLIP

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: Proof LH

DATE: 1/12/93

1. Pat C PPC
2. Jon D. JD
3. Roger / Duane RCS DGL

☑ Approval	☐ Comment	☐ Necessary Action
☐ Note and Return	☐ Note and File	☐ Investigate
☐ Prepare reply	☐ Signature	☐ See Me
☐ As requested	☐ For your information	☐ Per Conversation

REMARKS:

sw\butteold.wkp

mailed 1-15-93

FROM: P 3

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
(406) 444-1430

STAN STEPHENS, GOVERNOR
FAX #(406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 836 Front Street
Helena, Montana

MAILING ADDRESS: Cogswell Building
Helena, MT 59620

January 12, 1993

Edward L. Handl, P.E.
Special Resource Management, Inc.
P.O. Box 4168
Butte, Montana 59702

RE: **BUTTE-SILVER BOW LANDFILL, SILVER BOW COUNTY - LICENSE NO.20**
APPROVAL OF THE WORKPLAN FOR THE HYDROGEOLOGICAL AND SOILS STUDY.

Dear Mr. Handl:

After reviewing the "Workplan for the Hydrogeologic and Soils Study, Revision 2" and the letter dated January 7, 1993 from Special Resource Management, Inc. (SRM) addressing the deficiencies found in the Workplan for the above referenced facility, the Montana Department of Health and Environmental Sciences Solid Waste Program (the Department) approves these two documents together to constitute an adequate Workplan submittal.

Work may now commence toward collecting the necessary data for the Hydrogeological and Soils Study Report which will be due 180 calendar days from the date of this approval letter [see Administrative Rules of Montana (ARM) 16.14.703(1)(c)(ii)(C)].

NOTE:
If you should decide after some or all of the ground water monitoring wells are installed at the site that ground water quality sampling would be helpful in further assessing the hydrogeologic and soils conditions and characterization, ARM 16.14.706(2) requires that a Sampling and Analysis Plan (SAP) be submitted to and approved by the Department prior to conducting any sampling events. However, because the final intent of the Department is to have all SAPs represent site-specific conditions after the Ground Water Monitoring System has been determined, applicable company (i.e. SRM) Standard Operating Procedures may be submitted to the Department for a one-time initial sampling event approval. To insure analytical data validation throughout the sampling

history of the site, an SAP will inevitably be required coincident with an approved Ground Water Monitoring Plan.

Thank you for your tenacity, as well as your patience in working through the earlier deficiencies and providing a much improved workplan for the Butte-Silver Bow County Class II Landfill site.

Please call me if you have any questions, or if I can be of any help in expediting your work on the Hydrogeological and Soils Study Report.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, Montana 59701

Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, Montana 59701

Dan Powers, Paul Riley, Jon Rolich; Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

path: butteold.wkp
file: silver bow co/old butte ldfl/grd wtr

Silver Bow

ROUTE SLI

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: Pat C. ✓ DATE: 12/8/92

1. (Jon D) is reading a copy 12/8/92 pm. - OK made correct.
2. Roger
3. Duane DJR

☑ Approval
☐ Note and Return
☐ Prepare reply
☐ As requested
☐ Comment
☐ Note and File
☐ Signature
☐ For your information
☐ Necessary Action
☐ Investigate
☐ See Me
☐ Per Conversation

REMARKS:

Please route to Jon D. ASAP, I need this tomorrow for Butte/SRM meeting, if possible.

FROM: P 3

mailed 12-9-92 eh

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
(406) 444-1430

STAN STEPHENS, GOVERNOR
FAX #(406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 836 Front Street
Helena, Montana

MAILING ADDRESS: Cogswell Building
Helena, MT 59620

December 9, 1992

Butte-Silver Bow County Commissioners
155 West Granite Street
Butte, Montana 59701

RE: BUTTE-SILVER BOW LANDFILL, SILVER BOW COUNTY - LICENSE NO.20 REVIEW AND NOTICE OF DEFICIENCIES ON THE WORKPLAN FOR THE HYDROGEOLOGICAL AND SOILS STUDY/GROUNDWATER MONITORING PLAN.

Dear Commissioners:

The delay in this response to the Workplan submittal dated October 6, 1992 has been substantially based on the numerous deficiencies and the magnitude of the inadequacies in the document.

Prior to compiling the Workplan an intimate knowledge of the available geological, hydrogeological and site activities is necessary to avoid duplication of efforts, as well as to provide a valid basis for the proposals made in the Workplan. A summary of the above background data should be included in the Workplan. A preliminary list of all pertinent references, published and non-published, should also be provided as part of the Workplan. Copies of logs from domestic, stock/irrigation, and monitoring wells within at least a 1-mile radius of the site need to be included in the Workplan, along with a map showing the location of these wells.

A xerox copy of aerial photograph of the site and adjacent properties dated November 2, 1990 was provided in the Workplan. Unfortunately, adjacent drainages and topography are generally indistinguishable on this map. A topographic map would be helpful, however an accurate surveyed plat of the site will be necessary in determining the accurate direction of groundwater flow, migration paths, and man-altered influences. The section(s) township and range of the legal location of the landfill should appear on this map, as well.

On the copy of the aerial photo presented, the junk-vehicle yard appears to be outlined, but unlabeled. Please provide background

information on the "Mine Waste Disposal Area" which is labeled on the map.

Locate and provide pertinent information relevant to the landfill site concerning the following features:

Clark Tailings	Colorado Tailings
Blacktail Creek	Grove Creek
Sand Creek	local springs

Several letters found in the Department's file from the Department of Agriculture to the Soil Conservation Service dated November 26, 1979 and June 8, 1979 discuss an environmental evaluation of Grove Creek and the surrounding areas. A rough cross section incorporated with this data causes reason to fomulate the following questions pertinent to understanding the groundwater regime (natural and/or man-altered), at the landfill site:

- Was a by-pass/conveyance pipe ever installed around the landfill and the mine tailings area?
- Where are monitoring wells GW-2 and Gw-3 located in relation to the landfill?
- Do they still exist and is there any well construction or boring log information available on these wells?

In Section 2.0 "Site Conditions", the depth to groundwater is stated to range from 5 to 15 feet (I assume, this is below ground surface?). Please provide the documentation for this determination (i.e. wells, literature, etc.).

The Workplan text refers to the subsoils and subsurface as "alluvial valley-fill" overlying the Cretaceous Boulder batholith. However, due to the distinctive upland type slope from adjacent the bedrock exposures, terrace or colluvium might be more accurate description of the sub-soils and possibly to some extent the subsurface. To clarify this situation, please identify from the literature, the surface soils and subsurface geologic units found in the area and provide brief descriptions of the lithology in each of these units.

Section 3.0 "Site Investigation" stipulates that 12 shallow monitoring wells are proposed. How deep are these wells expected to be? In proposing these locations on the enclosed map, how did you determine the spots? Do you know the direction of "shallow" groundwater at the facility? If so, how was this direction determined, and provide the direction of flow.

If the direction of groundwater flow is already known at this site, why are so many shallow monitoring wells proposed. Each well represents a sampling point. If you do not plan to use all of these wells for monitoring, temporary piezometers might be used to measure the depth to groundwater, if that is needed.

Four (4) "deep" monitoring wells have also been proposed in Section 3.0 of the Workplan. Define "deep" as to lithology, approximate depth. The lateral and vertical extent of the "shallow" aquifer, possible contaminant constituents in the groundwater, and the concentrations of these constituents should be the primary focus of the initial part of the Hydrogeological and Soils Study investigation.

Monitoring of a "deep" aquifer/zone/unit could require casing-off and sealing the uppermost aquifer from the lower water-bearing unit before it is penetrated, if it is separated from the "shallow" aquifer by a confining layer. Attempt to determine from previous geologic and hydrogeologic studies of this area the following:

* Is there a confining layer beneath the uppermost aquifer?
* What is the age and lithology of this layer?
* What is the lateral and vertical extent of the layer?
* Is this truely a confining layer, or is there leakance involved?

A "deep" possible water-bearing unit is more likely the fractured bedrock. In the event that a Hydrogeological Study of the bedrock aquifer system at the landfill site is considered to be necessary, this could be a extensive investigation of fracture patterns, etc. to determine the paths of migration.

If, the "shallow"/"deep" groundwater monitoring well proposal is to address the possibility of non-aqueous phase liquids (NAPLs) and dense non-aqueous phase liquids (DNAPLs) at this site, this interpretation is premature. First, the vertical extent (i.e. the thickness) of the aquifer must be determined. Secondly, a constituent(s) concentration in the groundwater must be established through groundwater sampling and analysis. A substantial concentration of a chemical constituent(s) would be required to cause phase-separation. Dissolved contaminants in the parts per billion levels are the maximum levels monitored to date, at landfill sites in the State of Montana.

Seven (7) backhoe pits have been proposed at the site. The proposed locations of these pits appears to be in the active waste disposal areas at the site. If this is the case, the

locations will need to be moved or an alternative method proposed for shallow soil characterization. It should also be pointed-out that borings and monitoring wells cannot be advanced through waste.

Section 3.4 "Hydrogeologic Characterization", lists storativity as a parameter which will be derived from slug test data. Explain how this can be accomplished without an observation well

The following comments are directed at specific sections of the Workplan:

3.5.2 Soils Investigation Report
Soil samples should be described according to the Unified Soil Classification.

3.8 Health and Safety Considerations
The disposal of purge water and water used for decontamination that will be released on the ground at the site, should be restricted to non-waste disposal areas.

4.0 Investigation Deliverables
To satisfy the necessary Administrative Rules of Montana (ARM) requirements the following documents will be required for review and approval: A Hydrogeological and Soils Study Report, A Groundwater Monitoring Plan, and a SAP.

It is to the advantage of the Butte-Silver Bow to use all available data in the hydrogeological and soils investigative process. This existing data can then be supplemented by field borings and the determination of the depth to the uppermost aquifer. From this water level data, the direction of groundwater at the facility can more accurately be determined and appropriate locations for monitoring wells can be more efficiently spotted.

At this point, the quality of the groundwater in the uppermost aquifer should be evaluated by sampling and analysis. Based on the limited knowledge of the history of the site and surrounding area, it is anticipated that concentrations of metal in the groundwater will be high. However, mining activities generally are not directly associated with volatile organic compounds (VOCS) such as trichloroethene, tetrachloroethylene, and dichlorodifluoromethane, common contaminant constituents generally associated with landfilling activities. Therefore, it is anticipated that landfill leachate constituents will be distinguishable from leachate generated by mining operations.

Butte-Silver Bow is required to respond to these comments with a revised Workplan within 15 calendar days from the date they are received [ARM 16.14.703(1)(c)(ii)(B)]. If you have any questions and need clarification on any of the above issues, please give me a call.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, Montana 59701

Dan Powers, Paul Riley, Jon Rolich, R.S. Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

Ed Handl, P.E., SRM, Inc., P.O. Box 4168, Butte, MT 59702

path: sw\butteold.nod file: silverbowco/old butte/grdwtr

SENDER:

- Complete items 1 and/or 2 for additional services.
- Complete items 3, and 4a & b.
- Print your name and address on the reverse of this form so that we can return this card to you.
- Attach this form to the front of the mailpiece, or on the back if space does not permit.
- Write "Return Receipt Requested" on the mailpiece below the article number.
- The Return Receipt Fee will provide you the signature of the person delivered to and the date of delivery.

I also wish to receive the following services (for an extra fee):

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Butte-Silver Bow Co. Comm.
155 W. Granite Street
Butte, MT 59701

4a. Article Number
P 552 429 018

4b. Service Type

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☒ Certified ☐ COD
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7. Date of Delivery
7-8-92 TAP

5. Signature (Addressee)

8. Addressee's Address (Only if requested and fee is paid)

6. Signature (Agent)
Marie King

BUTTE, MT
JUL 8
1992
USPO

PS Form **3811**, November 1990 ☆U.S. GPO: 1991—287-066 **DOMESTIC RETURN RECEIPT**

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MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
Solid & Hazardous Waste Bureau
836 Front Street
Helena, MT 59620

Attn: P. Potts

P 552 429 018

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED
NOT FOR INTERNATIONAL MAIL
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Street and No. 155 W. Granite St.	
P.O., State and ZIP Code Butte, MT 59701	
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Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt showing to whom and Date Delivered	
Return Receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	$
Postmark or Date 7-7-92	

☆U.S.G.P.O. 1989-234-555

PS Form 3800, June 1985

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2. If you do not want this receipt postmarked, stick the gummed stub to the right of the return address of the article, date, detach and retain the receipt, and mail the article.

3. If you want a return receipt, write the certified mail number and your name and address on a return receipt card, Form 3811, and attach it to the front of the article by means of the gummed ends if space permits. Otherwise, affix to back of article. Endorse front of article **RETURN RECEIPT REQUESTED** adjacent to the number.

4. If you want delivery restricted to the addressee, or to an authorized agent of the addressee, endorse **RESTRICTED DELIVERY** on the front of the article.

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6. Save this receipt and present it if you make inquiry.

☆**U.S.G.P.O. 1989-234-555**

Butte-Silver Bow

ROUTE SLIP

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: "Proof" LH DATE: 7/2/92

1. Jim W JW
2. Jon D JD
3. Roger ~~RC~~ / Duane DLC

☐ Approval
☐ Note and Return
☐ Prepare reply
☐ As requested

☐ Comment
☐ Note and File
☐ Signature
☐ For your information

☐ Necessary Action
☐ Investigate
☐ See Me
☐ Per Conversation

REMARKS: "FORM" Letter - new, see yellow sticky

Laura ↓

Note: date may need to be changed if slow route. Then due date may change on back pg.

Pat - Do the dates need to change? Brenda

Thanks

FROM: P 3

mailed 7-7-92 lh

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
(406) 444-1430
STAN STEPHENS, GOVERNOR
FAX #(406) 444-1499
STATE OF MONTANA
OFFICE LOCATION: 836 Front Street Helena, Montana
MAILING ADDRESS: Cogswell Building Helena, MT 59620

July 7, 1992

CERTIFIED MAIL

Butte-Silver Bow County Commissioners
155 West Granite Street
Butte, Montana 59701

RE: BUTTE-SILVER BOW LANDFILL, SILVER BOW COUNTY - LICENSE NO. 20
HYDROGEOLOGICAL AND SOILS STUDY/REPORT, GROUNDWATER MONITORING PLAN & GROUNDWATER SAMPLING AND ANALYSIS PLAN

Dear Commissioners:

The above referenced landfill has been ranked as one of the more hydrogeologically sensitive landfill sites in the State of Montana, according to the Groundwater Protection Strategy issued by the U.S. EPA in 1984. This evaluation concept is based on the need for differential protection of groundwater depending on its resource value.

Due to the proximity of the Butte-Silver Bow landfill to potentially vulnerable groundwater and surface water resources, as well as the criteria that have been established in Section 75-10-207 of the Montana Code Annotated (MCA) for municipal solid waste landfills and other disposal sites, the Montana Department of Health and Environmental Sciences, Solid Waste Program (the Department) is requiring the above referenced landfill to comply with the Administrative Rules of Montana (ARM), Title 16, Chapter 14, Subchapter 7, Groundwater Monitoring Regulations. Specific points of compliance are discussed below.

Hydrogeological and Soils Study

The Butte-Silver Bow landfill is required to monitor the groundwater based on the following: the landfill has accepted household waste, it was in operation as of October 1, 1989 and serves an area with a population of 5,000 or more persons (see

"AN EQUAL OPPORTUNITY EMPLOYER"

Section 75-10-207, MCA). Therefore, the Department, according to the Administrative Rules of Montana (ARM) 16.14.703(1)(c)(ii) requires the owner/operator of this solid waste disposal facility to provide a Hydrogeological and Soils Study/Report (see ARM 16.14.703) to the State. The culmination of this report should center on the installation of groundwater monitoring wells (locations to be defined according to ARM 16.14.704), in an effort to establish an adequate and accurate groundwater monitoring network [see ARM 16.14.707(1)(b)].

Workplan

A Workplan for this Study/Report must be presented to the State for approval within 90 days from your receipt of this formal notification letter [see ARM 16.14.703(1)(c)(ii)(A)]. The Workplan should outline necessary research, field activities, locations of the proposed soil borings/test pits and groundwater monitoring well installations, as well as any lab and/or field tests needed to meet the data requirements for the final Hydrogeological Study/Report.

Please note the specific ARM standards for the number of borings and/or test pits required at the site [see ARM 16.14.703(1)(a)(x)(K)(III)], location and number of groundwater monitoring wells (see ARM 16.14.704), and the construction standards/requirements for groundwater monitoring wells (see ARM 16.14.705) to be installed around the perimeter of the waste disposal area(s).

If any of the groundwater monitoring wells proposed for use in the groundwater monitoring network at the Butte-Silver Bow landfill site are owned and operated, and possibly already being sampled as part of a separate facility's groundwater monitoring program, please state this in Workplan. Provide written approval from the property owner(s)/operator(s), and/or the specific site, facility or agency that may be responsible for the operation and maintenance of these wells that specifies the following information:

1) Butte-Silver Bow landfill is permitted to monitor and sample the groundwater from certain specified monitoring wells associated with the groundwater monitoring network of an adjacent facility, at scheduled semi-annual periods during the year for the life of the landfill and the closure-post closure period, or

2) Butte-Silver Bow landfill may have access to any groundwater sampling analytical results from, at least, semi-annual sampling events performed by the adjacent owner(s)/operator(s) or related facilities/sites or agencies, with the agreement that Butte-Silver Bow must be able to request any additional sampling parameters not included in the current adjacent facility's testing, but which are required in Table I of ARM 16.14.706.

A deviation from the required number of borings and/or test pits may be requested in the Workplan, as long as adequate geologic, soils and hydrologic characterization of

Groundwater Monitoring Plan will follow 180 days after the Department's approval of the Workplan. Please give me a call if you have any questions pertaining to this formal notification and/or the ARM Subchapter 7 regulations.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

Enclosures: ARM Subchapter 7
Groundwater Monitoring Well Construction Diagram
Groundwater Monitoring Well Development Form

cc: Jack Lynch, Chief Executive Butte-Silver Bow, 155 W. Granite, Butte, MT 59701

Jack Pomory, Operator, 1830 C Street, Butte, MT 59701

Dan Powers, R.S., Butte-Silver Bow Health Department, 25 W. Front Street, Butte, MT 59701

file: sw\busilv.gwt

WORK PLAN
FOR
HYDROGEOLOGIC AND SOILS STUDY
Revision 2
Butte-Silver Bow County Landfill Closure

Special Resource Management INC.

WORK PLAN
FOR
HYDROGEOLOGIC AND SOILS STUDY

Revision 2
Butte-Silver Bow County Landfill Closure

Prepared For:
Butte-Silver Bow

RECEIVED
DEC 23 1992
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

Prepared by:

Special Resource Management, Inc.
PO Box 4168
Butte, MT 59702

October 6, 1992
Revised December 21, 1992
SRM Project No.:31-00976-002

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1.0 INTRODUCTION

The purpose of this work plan is to describe, in detail, the investigatory work comprising the Hydrogeologic and Soils Study at the existing Butte-Silver Bow Landfill (Figure 1, 2, and 3). The existing landfill is located in Township 3 north, Range 8 west, Southeast ¼ of Section 25. All investigatory work will be completed according to Administrative Rules of Montana (ARM), Title 16, Chapter 14, Subchapter 7, Groundwater Monitoring Regulations. All well drilling, borings, backhoe pits, and well development will be documented on the Montana Department of Health and Environmental Sciences' Forms (Monitoring Well Construction Form, Soil Boring Form, and Well Development Form).

In addition to this study, a closure plan for the landfill will be completed and submitted for approval. Also, in conjunction with this study, a Sampling and Analysis Plan (SAP) and a Groundwater Monitoring Plan will be submitted for department approval.

1.2 Previous Investigations

Previous investigations of the area include a water resource study by O.E. Meinzer in 1914 and a hydrogelogic study by M.K. Botz in 1969. Both studies cover the upper Silver Bow creek drainage basin and do not specifically address site conditions. These studies describe the generalized stratigraphy of the Butte Valley and state that the basin formed in Late Tertiary or Early Quaternary. As the fault dropped basin formed, erosion from the uplands deposited quaternary alluvial (water deposited) sediments in the basin. These sediments range in size from boulders to clay and the depositional environment ranges from stream bed deposition (thin channels of sand and gravel sized materials) to lake bed deposition (large, thin deposits of silt and clay). Based on geologic mapping and review of several borings and mine shafts in the Butte Valley, the general stratigraphy of the valley from oldest to youngest is summarized below:

1. The bedrock in the valley consists of igneous rocks associated with the Cretaceous Boulder Batholith. The batholith is a combination of, at least, 19 different plutons varying in composition. The main pluton in the vicinity of the Butte Valley is composed of Butte Quartz Monzonite which forms most of the mountains and foothills in the area.

2. Quaternary Alluvial fill comprises the sediments in the valley. The thickness ranges from 0 at the contact with the batholith to 600 - 880 feet in the center of the valley. The lithology of the alluvium varies throughout the valley. Due to the relatively small discharge area for the valley and the deposition of fine grained sediments, it is thought that several times during the history of the valley, a large lake was formed. Based on well logs and mine shafts in the area, the lithology from the present surface to 100 feet consists of 50 to 100 feet of coarse grained sediments underlain by a fairly continuous layer of sandy silt or clay. The remainder of the sediments consists of mixtures of fine gravel, sand, silt, and clay.

Wells installed during the Grove Creek Project (GW-2 and GW-3) could not be located, however, three monitoring wells were installed during the summer of 1992. These wells were installed as part of the annual Field Hydrogeolgy camp for Montana College of Mineral Science and Technology. The wells are shown in Figure 1 as wells 5, 6, and 7, and logs are included in Appendix B of these wells and all wells within a one mile radius that are on file at MBMG. The lithologic description on these logs indicates alluvial deposition; clay layers, organic rich layers and thin discontinuous beds.

No other published information specifically describes the geology or lithology of the Landfill site. Therefore, from review of the literature, the presence of confining layers, age, lithology, lateral or vertical extent, or the integrity of the sediments under the site cannot be identified. This field investigation is designed to obtain detailed information describing all of the above conditions.

2.0 SITE CONDITIONS

The Butte-Silver Bow landfill is located in alluvial valley fill which lies on top of the Cretaceous boulder batholith. The site topography has been altered due to landfilling activities such as cutting, filling, and construction of a by-pass pipe to divert Grove Creek around the landfill area.

A soils investigation of the area (USDA, 1970) identifies the surface soil in the area as 2 soil types; RW - river wash, and Carbol and Lucky soils. The grove creek drainage below the landfill consists of the Slocum loam which is developed in alluvium from weathered granite. A vast majority of the sediments in the valley are alluvial (moved or deposited by water) in origin with the soils on the slopes of the hills being colluvium (moved or deposited by gravity).

The alluvial fill is expected to be fairly thin and is the water table aquifer in the area. Depth to water ranges between 5 and 15 feet below ground surface in the landfill area, maybe slightly deeper on the eastern edge. This depth was estimated from nearby well logs and the surface conditions of the site. Due to the shallow water table and the surface area which has been affected by landfill activities, an impact on groundwater quality is expected.

Additionally, the effect of the Clark mine/mill tailings on ground water quality is unknown. The Clark tailings are located to the east of the Landfill (Figure 3). A mill was located on the northern slope of Timber Butte, was operated by the Timber Butte Mining Company, and treated ore from the Elm Orlu Mine. The mill was in operation from 1914 to an unknown time before 1948, during which time the mill accumulated approximately 1 million cubic yards of tailings. The tailings were partially reclaimed by ARCO in the mid 1980's and ARCO expects to revisit the site at a later date as part of the Priority Soils Cleanup.

Well locations proposed in this Work Plan will identify impacts that may have occurred due to

the operation of the Butte-Silver Bow municipal landfill and will help characterize background water quality. The proposed monitoring well locations are not meant to completely identify all possible on site and off site routes of contamination, or the extent of contamination, but rather to identify a starting point for the investigation. Once these wells have been installed and monitored, the data will be used to propose well locations for the next phase of the investigation, if needed, or to define the wells needed for long term monitoring of the closed landfill.

3.0 SITE INVESTIGATION

The site investigation will include installation of seven (7) backhoe pits, six (6) soil borings, twelve (12) shallow monitoring wells, and four (4) deep monitoring wells. Locations are shown in Figure 3. A description of the subsurface investigation follows in chronological order. B Backhoe pits will be completed outside of the area underlain by refuse. These pits will be constructed to a depth of 10 feet and soil types, sedimentary structures, root depth, desiccation features,...etc. encountered in the pits will be described. Borings will be completed through the first aquifer and to the bottom of the first aquiclude if that aquiclude is sedimentary in origin. If the batholith is encountered the boring will be stopped. The shallow monitoring wells will be drilled to 5 feet below the first water. The screen for these wells will be placed from 5 feet below the water table to 5 feet above the water table to allow for seasonal fluctuations in groundwater elevations. Since site specific information of the depth to ground water is not available, the approximate ground water depth was estimated based on nearby well logs and site condition to be between 5 and 15 feet below ground surface. On the east end of the landfill, the depth to first water may be greater than 15 feet. The deep monitoring wells will be completed with 10 feet of screen on top of the first aquiclude, which could be either a sedimentary clay layer or bedrock. The deep monitoring well will allow the identification of water quality at the bottom of the aquifer, the determination of non-horizontal flow condition (recharge/discharge area), the vertical extent of the aquifer, and the presence or absence of any dense phase contamination.

Well placement was determined by the possibility of complex flow directions due to the placement of the landfill in the Grove Creek drainage which drains both to the North along the historical Grove Creek Drainage and to the Northeast along the present day drainage. Also, contamination of the ground water may be occurring from one small area of the landfill and the well locations will identify both groundwater flow directions and groundwater quality in each area of the landfill. Groundwater flow directions could be along either or both of these drainages depending on subsurface conditions.

The site consists of approximately 81 acres of landfill area and, therefore, will require 45 borings and/or backhoe pits according to ARM. Since the area has been filled with refuse, additional borings in the active area will not provide information on the natural geologic conditions at the site, completing the required number of borings will not supply any additional valuable information at this time. Also, since the potential for contamination at this site is very

high, additional wells will most likely be required to delineate a ground water contamination plume resulting from the landfill. This investigation will provide the necessary information to fully describe the geologic and hydrogeologic characteristics at the site and identify areas where water quality may have been impacted by landfilling activities. Enough sampling points must be placed around the landfill to identify all areas where contamination is possible and indicate where addition wells may be needed. Once the investigation is complete and the final groundwater monitoring plan is completed, wells not needed to monitor the site will be closed.

3.1 Record Search

In order to write the Work Plan, a literature search was conducted to gather all available information on the hydrology, geology, and hydrogeology of the site. This information was collected from the United States Geological Survey (USGS), the Montana Bureau of Mines and Geology (MBMG), the Department of Natural Resources and Conservation (DNRC), and the Department of Health and Environmental Sciences (DHES). During the coarse of the field investigation, if additional references are located, they will be included in the final report.

This information identifies regional stratigraphy, structural geology, and depositional history. Since very little investigatory work has been conducted at the site, site specific characteristics will have to be identified from data collected during this investigation.

3.2 Hydrologic Characterization

The hydrologic characterization will identify the recharge and discharge areas for the site. Identification will consist of mapping the recharge area, based on surface water divides. The groundwater discharge area will be delineated once ground water flow characteristics have been determined. Based on the above information plus precipitation data, a water budget for the site will be calculated.

3.3 Geologic Characterization

The geologic characterization shall identify all pertinent subsurface units in the landfill area. Boring logs shall be used to construct a geologic model of the site. Each unit encountered in the subsurface will be described and classified according to Unified Soil Classification System by a qualified professional.

Soil samples will be collected from five foot intervals on all borings and wells. Lithologic logs will be constructed for each boring and backhoe pit constructed at the site. Logs will be completed on the forms supplied by the Montana Department of Health and Environmental Sciences, Solid Waste Program. Samples of the surface soil will be analyzed for the following chemical characteristics: Soil Organic Content (SOC), pH, and Cation Exchange Capacity

(CEC). Soil and subsurface materials will be analyzed for the following physical parameters: Grain Size Distribution and Atterberg Limits.

The information gathered during the investigation will be used to construct geologic cross sections of the site. These cross sections will provide the basis for interpretation of the aquifer extent and interconnection across the site.

3.4 Hydrogeologic Characterization

The hydrogeologic investigation of the site will identify and describe all hydrogeologically significant units at the site. Each unit will be characterized by the following physical parameters: Soil Classification and Grain size. The following hydraulic parameters will be determined by conducting slug tests and constructing well logs for each monitoring well: Hydraulic Conductivity (K), Transmissivity (T), Storativity (s), Thickness (b), and lateral extent of the aquifer. K, T, and s can be determined by interpretation of slug test data. The interested reader is referred specifically to Fetter, 1988 or Cooper, 1967 for interpretation methods. The lateral and vertical extent of the aquifer will be measured and determined by borings.

Information derived from the proposed soil borings and monitoring wells will identify the following groundwater characteristics of the site; flow direction and flow velocity. Based on these data, the need for additional wells will be assessed and proposed, if necessary.

3.5 Data Reporting

3.5.1 Hydrogeologic Report

The hydrogeologic report will include a description of the surface water characteristics of the sites including estimated flow volumes, aquifer recharge and discharge, precipitation characteristics, and documentation and calculations for the site water budget.

The hydrogeologic report will define the subsurface geologic conditions of the site. Several cross sections will be generated depicting the extent (to include depth, thickness, and lateral extent) of geological units which may direct and/or restrict leachate migration pathways. Geologic features identified during field investigations will include a description of unconsolidated deposits, the presence, depth, and thickness of aquicludes, and identification of fracture zones.

The hydrogeologic report shall include construction details, locations, elevations, lithologic logs, and sampling data of all proposed wells, borings, and backhoe pits. Cross sections generated from the boring logs will depict the water bearing zones and subsurface hydrogeology. Based

on the field data, tests and cores, a representative and accurate classification and description of the hydrogeologic units and significant aquifers shall be presented.

The hydrogeologic report shall include and explain all calculations supporting the groundwater flow directions and velocities, determinations of hydraulic conductivity, transmissivity, porosity, permeability, and estimated leachate transport times. The subsurface hydrologic characterizations will be based on field slug tests.

3.5.2 Soils Investigation Report

The soil units above the water table will be described and characterized according to the Unified Soil Classification System, atterberg limits, size distribution, organic content, pH, mineral content, and moisture content. All of these data will be provided in the Soils Investigation Report. This report will also contain a soil distribution map and soil profiles for the site.

3.6 Decontamination Process

To ensure reliable sample quality, all drilling equipment shall be decontaminated with an appropriate cleaning technique before mobilization and between borings. When soil samples are collected, the sampling equipment shall be decontaminated prior to collection of each soil sample. Appropriate cleaning techniques shall include steam cleaning and/or a laboratory grade detergent wash and distilled water rinse. All foreign materials on sampling tools (i.e. soil, refuse...) will be removed.

All bailers and sample containers shall be laboratory cleaned or decontaminated by an appropriate cleaning technique. At no times shall a suspected contaminated sampling tool be re-used without first being decontaminated. It is the responsibility of the field personnel to follow accepted procedures when decontaminating and cleaning sampling equipment and tools in the field.

3.7 Sampling Details

SRM has developed a drilling and backhoe pit excavation program to generate the necessary information to characterize hydrogeologic, hydrologic and geological conditions at the referenced project site. The following tables present the sampling quantities that will be collected to characterize the subsurface geological and hydrogeological units, and groundwater quality.

Table 3.7.1 Backhoe Excavation Samples

Sample	**pH**	**SOC**	**CEC**
Backhoe Pit	One sample per Backhoe pit	One Sample per Backhoe Pit	One sample per Backhoe pit

Table 3.7.2 Soil Boring Samples

Sample	**Sieve Analysis**	**Atterberg**
Soil Boring	3 Samples per water bearing zone	1 Sample per Soil Type

Table 3.7.3 Monitoring Well Samples

Sample	**Appendix A Parameters**
Monitoring Well	One Water Sample Per Well(1)

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[1] To be collected after Sampling and Analysis Plan has been approved by the Department.

3.8 Health and Safety Considerations

Ground water contamination at the site is expected to consist of elevated concentrations of major anions, cations, metals, and possibly synthetic compounds in the parts per billion range. Therefore, protective cotton coveralls, rubber gloves, safety glasses, and a hard hat will provide adequate protection. These initial precautions will prevent potentially contaminated ground water from contacting sampling personnel. If ground water at the site is determined to be highly contaminated, a Health and Safety Plan will be completed for the site before additional sampling will be conducted.

Field monitoring data will be used during sampling to determine if purge water from the monitoring wells will need to be containerized. If the initial photoionization reading or the field ground water monitoring parameters (pH, SC, Temp.) indicate a degraded water quality, purge water will be containerized until the analytical results are available from the lab. The laboratory results will be used to determine the disposal options for the purge water. If the water is determined to be nonhazardous, it will be disposed of on the ground at the site but restricted to non-waste disposal areas.

3.8.1 Methane Monitoring

Since this is an old landfill and methane production is possible, monitoring for combustible gases will be performed in and around the bore hole as follows:

1) At the beginning of each work shift.
2) Following extended periods when the control/exclusion zone has been evacuated.
3) Prior to any spark or flame producing activity that is within ten (10) feet of the bore hole.
4) Monitoring will be conducted within a three (3) foot radius of the borehole.

If combustible gas levels exceed 10% LEL, no flame or spark producing operations may be performed. The bore hole must be allowed to ventilate until the levels drop to background and the source can be identified.

As per manufacturer's requirements, the Combustible Gas Analyzer will be calibrated on a monthly basis. Calibration will consist of comparing instrument read-out in " % LEL ", with a span gas. If the results of the comparison are not within the limits of the manufacturer's specifications, the instrument will be adjusted accordingly.

4.0 INVESTIGATION DELIVERABLES

All data collected from the investigation will be summarized into two reports: Hydrogeologic Characterization of the Butte-Silver Bow Landfill and Soil Investigation Report for the Butte-Silver Bow Landfill. These reports will provide the information necessary to satisfy ARM Title 16, Chapter 14, Subchapter 7 Groundwater monitoring regulations. After completion of these reports, both the Groundwater Monitoring Plan and the SAP will be submitted to the State for review.

5.0 PROJECT SCHEDULE

A tentative project schedule for the Butte-Silver Bow Landfill Hydrogeologic and Soil Study is shown in Table 5.1. The drilling and backhoe pit excavation activities can commence approximately 20 days after the Department approves the work plan. The field activities should be completed within 160 days of the Department's approval. As required by regulations, within 180 days of Department approval, relevant information and laboratory results shall have been compiled, and the final reports submitted to the state for review. Since start of the field work is contingent on Department approval of the work plan, actual dates for field activities are subject to change.

Table 5.1 Project Schedule (days after Department approval)

Task	Start	Completion
Borings and Backhoe pits	20	45
Shallow Monitoring Wells	30	60
Deep Monitoring Wells	45	70
Aquifer Tests	70	90
Soil Analysis	30	60
Ground Water Sampling	70	90
Ground Water Analysis	85	120
Report Preparation and Review	100	160
Final Report	160	180

6.0 CONCLUSIONS

The Butte-Silver Bow County Landfill hydrogeologic and soil study program will generate the necessary information to properly characterize the site. The program shall consist of drilling soil borings and excavating backhoe pits at various locations to characterize the subsurface, hydrologic and geologic conditions. Monitoring wells will be completed (as determined by the on site hydrogeologist) to evaluate and detect the existing or potential contamination at this facility. The hydrogeologic study will provide meaningful data on the distribution and characteristics of the aquifer(s), define the groundwater flow system, evaluate the extent and rate of lateral and vertical migration of contamination from the source, and characterize the degree and nature of contamination.

The soils will be described and classified according to Unified Soil Classification System. The results of the study will define the effect of soil stratification on unsaturated and saturated flow.

7.0 REFERENCES

Botz, M.K., Hydrogeology of the Upper Silver Bow Creek Drainage Area, Montana, Montana Bureau of Mines and Geology, Bulletin 75, Sept., 1969

Cooper, H.H., J.D. Bredehoeft, and S.S. Papadopulos, Response of a finite diameter well to an instantaneous charge of water, Water Resource Research, vol. 3 no. 1, pp. 263-260

Fetter C.W., Applied Hydrogeology, Second Edition, Merrill Publishing, 1988

Montana Geologic Atlas - Butte Geology Sheet, Preliminary Edition No. 1, Montana Bureau of Mines and Geology, MBMG 53, 1976.

Straw, Tom, Geology for Planning, Butte-Silver Bow Planning Area, Montana Bureau of Mines and Geology, MBMG 58,

Smedes, H.W., Open-File Maps of Butte South Quadrangle, Montana, Montana Bureau of Mines and Geology, Maps 73 - 76, 1967.

United States Department of Agriculture, Soil Survey & Interpretations for Resource Planning & Urban Development in the Area of Butte, Montana, Soil Conservation Service, 1970

Appendix A

Groundwater Analytes

Parameter	EPA Method	Detection Limit(mg/l)
Water Quality		
Ammonia	350.1	0.1
Bicarbonate	310.1	1
Calcium	215.1	1
Chloride	325.3	1
Iron	236.1	0.03
Magnesium	242.1	1
Manganese	243.1	0.02
Nitrate	353.2	0.05
Potassium	258.1	1
Sodium	273.1	1
Sulfate	375.3	1
COD	410.1	1
TDS	160.1	1
TOC	415.2	2
TSS	160.2	1
SC	120.1	1 μmhos/cm
pH	150.1	0.01 STD units
Metals		
Arsenic	206.3	0.005
Barium	208.1	0.1
Cadmium	213.1	0.001
Chromium	218.1	0.02
Cyanide	335.3	0.005
Lead	239.2	0.01
Mercury	245.2	0.001
Selenium	270.3	0.005
Silver	272.2	0.005
Volatile Organic Compounds		
VOC	8240	Dependant upon matrix

Appendix B. Area Well Logs

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LIST WELLS LOCAT SHORT.NAME TD SWL PERF.FROM PERF.TO YIELD WATER.USE YEAR WITH TWN.RNG = "03N 08W" WITH SEC =  25 26 27 34 35 36 BY
LOCAT ID.SUP LITH.LOG LPTR DBL.SPC 10:16:41   12-15-92   PAGE      1
                                        TOTAL     STATIC        PERF       PERF
                                        DEPTH     WATER         FROM       TO         YIELD     WATER                           Lithology
LOCATION............ SITE NAME........... FEET.... LEVEL (FT) (FT).... (FT).... GPM..... USE................. YEAR LITH LOG
03N 08W 25 #8          DUGDALE STANFORD       400.0                   380.0     400.0      40.0 DOMESTIC             1979 1
03N 08W 25 A#9         ROSHULT DOUG            84.0      25.00                             20.0 DOMESTIC             1983 1
03N 08W 25 AB#10 01    LLOYD DAN               80.0      30.00         71.0      78.0      30.0 DOMESTIC             1992
03N 08W 25 ACCC#11     REAP KENNETH            45.0      14.00         38.0      43.0      10.0 DOMESTIC             1973 1
03N 08W 25 B #18       LAVELLE W.P.            80.0                                             DOMESTIC             1963 2
03N 08W 25 BA#12 01    MOUNT MORIAH            58.0      25.00         48.0      56.0      40.0 IRRIGATION           1991
                       CEMENTARY
03N 08W 25 BA #13 01   MOUNT MORIAH            50.0      20.00         41.0      49.0      70.0 DOMESTIC             1991
                       CEMENTARY
                                                                                                IRRIGATION
03N 08W 25 BA#14 01    MOUNT MORIAH
                       CEMETARY
03N 08W 25 BA#15 01    MOUNT MORIAH            54.0      20.00         45.0      54.0      60.0 IRRIGATION           1990
                       CEMETARY
03N 08W 25 BA#16 06    MOUNT MORIAH           205.0     150.00        150.0     205.0      40.0 IRRIGATION           1991
                       CEMENTARY
03N 08W 25 BAB #19     MOUNTMORIAH CEM. #3     36.0                                       300.0 IRRIGATION           1925 2
03N 08W 25 BAB #20     MOUNTMORIAH CEM. #2     36.0                                       300.0 UNUSED               1925 2
03N 08W 25 BAB # 21    MOUNTMORIAH CEM. #4     36.0                                       300.0 IRRIGATION           1925 2
03N 08W 25 BAB# 22     MOUNTMORIAH CEM. #5     36.0                                       300.0 IRRIGATION           1925 2
03N 08W 25 BAB #23     MOUNT MORIAH CEM        36.0                                       300.0 IRRIGATION           1925 2
03N 08W 25 BB #24      DUNVILLE HAROLD         82.0                                        10.0 DOMESTIC             1951 2
03N 08W 25 BBB#17      WOLF JOHN               80.0      10.00                             25.0 DOMESTIC             1983 1
03N 08W 25 DC#1 01     KISSEL PAUL AND        240.0                   200.0     240.0      30.0 DOMESTIC             1992
                       CAROLYN
03N 08W 25 DCA #2      ANZIK MIKE             295.0      40.00        200.0     295.0      30.0 DOMESTIC             1988 1
03N 08W 26 ACD#3       JENKIN JOE             230.0      10.00        170.0     180.0       5.0 DOMESTIC             1984 1
03N 08W 26 CCCC#4      BRASIER FRANK          100.0      32.00         45.0      50.0      10.0 DOMESTIC             1976 1
03N 08W 26 DDB#5 01    WOODARDS DAN            16.6      11.00         11.1      16.1           MONITORING           1992
03N 08W 26 DDC#6 01    WOODARDS DAN            22.0                    11.5      21.5           MONITORING           1992
03N 08W 26 DDD#7 01    WOODARDS DAN            17.1                     6.0      16.0           MONITORING           1992
03N 08W 35 CAA #25     GRANT C E               62.0                                        41.0 DOMESTIC             1963 2
                                                                                                STOCKWATER

25 records listed.
```

1 or nothing = lithology available

2 = no lithology

utte 03N 08W 25 DC Silver Bow

088926

#1

WELL LOG REPORT

1. WELL OWNER
Name PAUL & CAROLYN KISSELL

2. CURRENT MAILING ADDRESS
210 CLAY
BUTTE, MT 59701

3. WELL LOCATION SAME
County SILVER BOW
Township 3N N/S Rang 8W E/W
SW 1/4 SE 1/4 SECTION 25
Lot________ Block________
Subdivision________
Tract Number________

4. PROPOSED USE Domestic X
Irrigation ____ Stock ____
Other: ____

5. DRILLING METHOD Cable
Rotary: X Air ____ FWD ____ Reverse
____ Jetted ____ Other: ____

6. WELL LOG

From	To	Formation
0	5	Top Soil
5	58	Decomposed Gravel & Sand
58	100	Granite & Water
100	220	Granite-Soft Sand-Gravel
220	240	Gravel-Granite-Water

PA

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date: JUNE 24, 1992

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT 59702
Dan O'Keefe 462
Signature License No.
Dan O'Keefe

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	0	58
4"	PVC	10	240

COMPLETIONS
perforations________ screen________

Kind	From feet	To feet
Skill Saw	200	240

Was casing left open? YES
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 58 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump ____ Bailer ____
B. Static Water Level before: FT
If flowing closed in pressure
____ PSI ____ GPM
Controlled by:
C. Depth of Pump for Test Air FT
D. Pumping Rate & Discharge 30 GPM
E. Maximum Drawdown for test FT
F. Duration of test:
Pumping time: HRS.
Recovery Time: HRS.
G. Recovery Water Level 240 FT
Time after pumping recovery water data was taken HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED JUNE 24, 1992

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M:128005

Butte 093 - 3N 8W 25 DCA Silver Bow

JUL 1 [illegible]

#2

MONTANA DEPT
RESOURCES & 044477

WELL LOG REPORT

1. WELL OWNER

Name Mike anzik

2. CURRENT MAILING ADDRESS

133 Clay
Butte, MT 59701

3. WELL LOCATION

County SilverBow
Township 3 N Range 8 W
NE 1/4 SW 1/4 SE 1/4 Section 25
Lot ____ Block ______________
Subdivision ____________________

4. PROPOSED USE

Domestic X
Irrigation Stock __ Other_ ______

5. DRILLING METHOD

__Cable__Bored
X Fwd Rotry __ Rvs Rotary__ Jetted

6. WELL CONSTRUCTION

size hole	size/wt. casing	From feet	To feet
6"	6 5/8" X.250	+2'	20'
4"	PVC #200	10'	295'

COMPLETIONS
perforations _________ screen ________

Kind	From feet	To feet
Skill Saw	200'	295'

Was casing left open? YES
Was a packer/seal used? NO
Well gravel packed? NO
Well grouted? YES
Bentonite-continuous fed
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

7. TEMPERATURE OF WATER

Degrees Fahrenheit ______________
Estimated ______ Measured ______

8. WATER LEVEL

Static water level: 40' feet below land surface
If flowing; closed in pressure
________psi __________ GPM
Contolled by:

9. WELL TEST DATA

___pump ___bailer___other: Air
Pumping water level below surface
after 2 hrs pumping level 160 GPM 30
after ___hrs pumping level___ GPM:

10. WELL PLUGGED OR ABANDONED? no

If yes, how? _______________

11. DATE COMPLETED June 10, 1988

12. WELL LOG

Depth ft. From	To	Formation
0	8	Top Soil
8	25	Sand Stone
25	295	Decomposed Granite

13. DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: July 7, 1988

O'Keefe Drilling Company
P.O. Box 3810 - 4 Mile Road
Butte, MT. 59702

Dan OKeefe 462
Signature License No.

Dan O'Keefe

MONTANA DEPARTMENT OF NATURAL RESOURCES 1520 E 6th Ave Helena, MT 59620

BUTTE

Form No. 603 R8/83

RECEIVED
JUN 07 1984
MONTANA DEPT. OF NATURAL RESOURCES & CONSERVATION

093 03N 08W 26 ACD

File No. Silver Bow

#3

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after complet

026490

1. WELL OWNER
Name Joe Jenkin

2. CURRENT MAILING ADDRESS
Little Basin Creek Road
Butte, Montana 59701

3. WELL LOCATION LITTLE BASIN ROAD
County Butte-Silver Bow
Township 3 N N/S Range 8 W E/W
SE ¼ SW ¼ NE ¼ Section 26
Lot ______ Block ______
Subdivision ______

4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐
Other ☐ specify ______

5. DRILLING METHOD ______ cable, ______ bored,
X forward rotary, ______ reverse rotary, ______ jetted,
______ other (specify) ______

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations and/or Screen Kind Size	From (feet)	To (feet)
6"	6 5/8" od x .250	+2'	18'			
	4" PVC 200#	10'	230'	Slots	170' 210'	180' 230'

Was casing left open end? X Yes ______ No
Was a packer or seal used? ______ Yes X No
If so, what material ______
Was the well gravel packed? ______ Yes X No
Was the well grouted? ______ Yes X No
To what depth? ______
Material used in grouting ______
Well head completion: Pitless adapter ______ Yes ______ No
Top of casing 12 in. or greater above grade X Yes ______ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
______ Degrees Fahrenheit
☐ Measured ☐ Estimated

8. WATER LEVEL
Static water level ______ feet below land surface
If flowing; closed-in pressure ______ psi
______ gpm
Controlled by: ______ valve, ______ reducers,
______ other, (specify) ______

9. WELL TEST DATA ______ pump ______ bailer
X other, (specify) air compressor
Pumping water level below land surface:
______ ft. after ______ hrs. pumping 5 gpm
______ ft. after ______ hrs. pumping ______ gpm

10. WAS WELL PLUGGED OR ABANDONED? ______ Yes X No
If yes, how? ______

11. DATE COMPLETED May 10, 1984

12. WELL LOG

Depth (ft.) From	To	Formation
0'	3'	Top soil
3'	8'	Sand
8'	16'	Decomposed granite
16'	160'	Decomposed granite - seepage
160'	230'	Granite
		Water - 5 gpm

DO'K/LP (use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
5/23/84
Date
O'Keefe Drilling Company 4 Mile Road
Firm Name
P.O. Box 3810 - Butte, Montana 59702
Address
Signature Ed O'Keefe 287 License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
32 SOUTH EWING HELENA, MONTANA 59620 449-3962 DNRC

State Publishing Co. Helena, Mont.

DEPARTMENT - BUREAU COPY

orm No. 603 (Rev. 3/75) 09303N8W26CCCC

File No.

STATE OF MONTANA Silver Bow

VISITED: 11/10/79 Department of Natural Resources and Conservation

058164

Gold-Driller #4

WELL LOG REPORT ② 7510 9760

State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

WELL OWNER
Name Frank Brasier
Current address 99 3rd Street, Butte, Montana 5970

WELL LOCATION Lot ______, Block ______, Subdivision [illegible]
County Silver Bow, or SW ¼ SW ¼ SW ¼ Sec. 26, T. [illegible], R. 8 [illegible]

PROPOSED USE X domestic (includes lawn and garden); ___ stock; ___ municipal; ___ industrial; ___ irrigation; ___ other (specify) Butte South NE 5680

METHOD DRILLED X cable, ___ bored, ___ forward rotary, ___ reverse rotary, ___ jetted, ___ other (specify) ______

WELL CONSTRUCTION
Diameter of hole 6 in.; depth 100 ft.
Casing: X steel, X plastic, ___ concrete, ___ threaded, X welded, X other (specify) glued/screwed
Pipe weight:

	Dia.	From	To
50 lb/ft	6 5/8 in.	+2 ft.	48 ft.
40 lb/ft	5"PVC in.	40 ft.	100 ft.

Was casing left open end? X Yes ___ No
Was a well screen installed? ___ Yes X No
Material ______, dia. ______ in.
(stainless steel, bronze, etc.)
Was perforated pipe used? X Yes ___ No
Perforation type: X slots ___ holes
Size 1/8" set from 45 ft. to 50 ft.
Size ___ set from 80 ft. to 100 ft.
Was a packer or seal used? ___ Yes X No
If so, what material ______
Well type: ___ Straight screen ___ Graveled
Was the well grouted: ___ Yes X No
To what depth: ______ ft.
Material used in grouting ______
Well head completion: Pitless adapter ___
12 in. above grade ___, other ______
(if other, specify) ______
Was well disinfected? X Yes ___ No

WATER LEVEL
Static water level 37 ft. below land surface
If flowing: closed-in pressure ______ psi
gpm flow ______ through ______ inch pipe
Controlled by: ___ valve ___ reducers
___ other (specify) ______

WELL TEST DATA ___ Pump X Bailer ___ Other
(if other, specify) ______
Pumping level below land surface:
___ ft. after ___ hrs. pumping 10 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG

Depth (ft) From	To	Formation 120PLNC
0'	1'	Top soil
1'	19'	Decomposed granite
19'	40'	Granite (seepage)
40'	100'	Granite (water)

(use separate sheet if necessary)

9. DATE STARTED 1/1/76
DATE COMPLETED 1/3/76

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If so, how? ______

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

O'Keefe Drilling Company 281
Driller's or firm name License No.

P.O. Box 3810, Butte, Montana 59701
Address

2/13/76
Signed by date

3N08W26DDB Silver

Wells near Landfill
5, 6, 7, 8, 11, 12-16,
19-23, 25
on printout

o. 603 (R 2-89)

WELL LOG REPORT

File No. ______

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion ~~of the well.~~

109180

WELL OWNER
Name DAN WOODARDS

2. CURRENT MAILING ADDRESS
1315 ADAMS AVE.
BUTTE, MT 59701

WELL LOCATION
NW ¼ SE ¼ SE ¼ Section 26
Township 3N N/S Range 8 W E/W County SILVER BOW
Govn't Lot ______, or Lot ______, Block ______
Subdivision Name ______
Tract Number ______

PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☒ specify MONITOR WATER LEVEL

TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐ AUGERED ☒
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ — Rotary ☐ Jetted ☐

DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 17 ft.
Dia. ______ in. from ______ ft. to ______ ft.
Dia. ______ in. from ______ ft. to ______ ft.

CONSTRUCTION DETAILS:
Casing; Steel Dia. ______ from ______ ft. to ______ ft.
Threaded ☐ Welded ☐ Dia. ______ from ______ ft. to ______ ft.
Type ______ Wall Thickness ______
Casing; Plastic Dia. 2" from -2.1 ft. to 16.6 ft.
Weight SCHED 40 Dia. ______ from ______ ft. to ______ ft.

PERFORATIONS: Yes ☐ No ☒
Type of perforator used ______
Size of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

SCREENS: Yes ☒ No ☐
Manufacturer's Name TRILOC
Type ______ Model No. ______
Dia. 2" Slot size 0.020 from 11.1 ft. to 16.1 ft.
Dia. ______ Slot size ______ from ______ ft. to ______ ft.

GRAVEL PACKED: Yes ☐ No ☒ Size of gravel ______
Gravel placed from ______ ft. to ______ ft.

GROUTED: To what depth? 1.5 ft.
Material used in grouting BENTONITE PELLETS

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name ______
Type ______ Model No. ______ HP. ______

0. WELL TEST DATA

The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.

All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:

a) Air ______ Pump ______ Bailer ______
b) Static water level immediately before testing ______ ft. If flowing; closed-in pressure ______ psi. ______ gpm.
Flow controlled by: ______ valve, ______ reducers, ______ other, (specify) ______
c) Depth at which pump is set for test ______
d) The pumping rate: ______ gpm.
e) Pumping water level ______ ft. at ______ hrs. after pumping began.
f) Duration of test: Pumping time ______ hrs.
g) Recovery time ______ hrs.
h) Recovery water level ______ ft. at ______ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a perio hours or more. The test shall follow the development of the well, and sh conducted continuously at a constant discharge at least as great as tended appropriation. In addition to the above information, water leve shall be collected and recorded on the Department's "Aquifer Test form.

NOTE: All wells shall be equipped with an access port ½ inch minim a pressure gauge that will indicate the shut-in pressure of a flowing w movable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? ______ Yes X No
If yes, how? ______

12. WELL LOG

Depth (ft.) From	To	Formation
0	8	sand w/ minor pebbles med brown color, moist
8	11	Clayey silt w/ some sand cobble encountered @ 10 ft
11	15	Sandy clay w/silt weathered bedrock (granite)
15	17	Coarse sand in clay (more weathering but sand size is coarser) STOPPED ON BEDROCK OR LARGE BOULDER
		SWL 11ft b.l.s.
		Well in coulee below granite outcrop
		TD = 16.6
		PA

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 7/22/92

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/1/92
Date

MONTANA TECH
Firm Name

W. PARK ST.; BUTTE, MT 59701
Address

John Sonderegger MWC-016
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION **DNRC**
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

#6

tte

3N 08W 26 DDC

Silver Bow

No. 603 (R 2-89)

WELL LOG REPORT

File No. ________

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1091807

1. WELL OWNER
Name DAN WOODARDS

CURRENT MAILING ADDRESS
1315 ADAMS ST
BUTTE, MT 59701

WELL LOCATION
SW ¼ SE ¼ SE ¼ Section 26
Township 3 N N/S Range 8 W E/W County SILVER BOW
Gov't Lot ________, or Lot ________, Block ________
Subdivision Name ________
Tract Number ________

PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☒ specify MONITORING,

TYPE OF WORK:
New well ☒ Method: Dug ☐ Bored ☐ AUGERED ☒
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

DIMENSIONS: Diameter of Hole
Dia. 11 in. from 0 ft. to 21.5 ft.
Dia. ____ in. from ____ ft. to ____ ft.
Dia. ____ in. from ____ ft. to ____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. ____ from ____ ft. to ____ ft.
Threaded ☐ Welded ☐ Dia. ____ from ____ ft. to ____ ft.
Type ____ Wall Thickness ____
Casing; Plastic Dia. 2" from -1.55 ft. to 11.5 ft.
Weight SCHED 40 Dia. ____ from ____ ft. to ____ ft.
PERFORATIONS: Yes ☐ No ☐
Type of perforator used ________
Size of perforations ____ in. by ____ in.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
____ perforations from ____ ft. to ____ ft.
SCREENS: Yes ☒ No ☐
Manufacturer's Name TRILOC
Type MONITORING Model No. [illegible]
Dia. 2" Slot size 0.020 from 11.5 ft. to 21.5 ft.
Dia. ____ Slot size ____ from ____ ft. to ____ ft.
GRAVEL PACKED: Yes ☒ No ☒ Size of gravel 20-40 SAND
Gravel placed from 21.6 ft. to 9.3 ft.
GROUTED: To what depth? 0-2, 7.3-9.3 ft.
Material used in grouting 0-2 cement, 7.3-9.3 bentonite

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

9. PUMP (if installed)
Manufacturer's name ________
Type ________ Model No. ________ HP. ________

10. WELL TEST DATA

The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.

All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:

a) Air ____ Pump ____ Bailer ____
b) Static water level immediately before testing ____ ft. If flowing; closed-in pressure ____ psi. ____ gpm.
Flow controlled by: ____ valve, ____ reducers, other, (specify) ____
c) Depth at which pump is set for test ____
d) The pumping rate: ____ gpm.
e) Pumping water level ____ ft. at ____ hrs. after pumping began.
f) Duration of test: Pumping time ____ hrs.
g) Recovery time ____ hrs.
h) Recovery water level ____ ft. at ____ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? ____ Yes ____ No
If yes, how? ________

12. WELL LOG

Depth (ft.) From	To	Formation
0	3	Fine-med sand w/silt,
		dk brn - organic rich
3	4	Fine sand Lt brown
4	9.5	Med-coarse sand w/ minor
		clay stringers increasing
		with depth
		DAMP @ 9 ft,
9.5	11	Sandy micaceous clay
11	13	Fine-med sand, micaceous
13	14	med-coarse sand, some clay
14	22	Sandy clay

PA

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 7/22/92

14. DRILLER/CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/1/92
Date

MONTANA TECH
Firm Name

W. PARK ST.; BUTTE MT 59701
Address

John Sonderegger MWC-016
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

7

utte

3N08W26 DDD

SILVER BOW

o. 603 (R 2-89)

WELL LOG REPORT

File No. ______

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well.

1 29806

WELL OWNER
Name DAN WOODARDS

CURRENT MAILING ADDRESS
1315 ADAMS AVE
BUTTE MT 59701

WELL LOCATION
SE ¼ SE ¼ SE ¼ Section 26
Township 3N N/S Range 8W E/W County Silver Bow
Govn't Lot ______, or Lot ______, Block ______
Subdivision Name ______
Tract Number ______

PROPOSED USE: Domestic ☐ Stock ☐ Irrigation ☐
Other ☒ specify Monitoring

TYPE OF WORK:
New well ☐ Method: Dug ☐ Bored ☐ Augered ☒
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

DIMENSIONS: Diameter of Hole
Dia. 11 in. from 0 ft. to 17.1 ft.
Dia. ______ in. from ______ ft. to ______ ft.
Dia. ______ in. from ______ ft. to ______ ft.

CONSTRUCTION DETAILS:
Casing; Steel Dia.______ from______ft. to______ft.
Threaded ☐ Welded ☐ Dia.______ from______ft. to______ft.
Type______ Wall Thickness______
Casing; Plastic Dia. 4" from -3.5 ft. to 16.6 ft.
Weight SCHED 40 Dia.______ from______ft. to______ft.
PERFORATIONS: Yes ☐ No ☐
Type of perforator used ______
Size of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

SCREENS: Yes ☒ No ☐
Manufacturer's Name Diversified Well Products
Type Monitoring Model No. ______
Dia. 4" Slot size 20 from 6 ft. to 16 ft.
Dia. ______ Slot size ______ from ______ ft. to ______ ft.

GRAVEL PACKED: Yes ☒ No ☐ Size of gravel 10-20 SAND
Gravel placed from 17.1 ft. to 5 ft.

GROUTED: To what depth? ______ ft.
Material used in grouting 0-1.5 concrete 3-5 bentonite

WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☒ No

PUMP (if installed)
Manufacturer's name ______
Type ______ Model No. ______ HP. ______

WELL TEST DATA

The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.

All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:

a) Air ______ Pump ______ Bailer ______
b) Static water level immediately before testing ______ ft. If flowing; closed-in pressure ______ psi. ______ gpm. Flow controlled by: ______ valve, ______ reducers, ______ other, (specify) ______.
c) Depth at which pump is set for test ______
d) The pumping rate: ______ gpm.
e) Pumping water level ______ ft. at ______ hrs. after pumping began.
f) Duration of test: Pumping time ______ hrs.
g) Recovery time ______ hrs.
h) Recovery water level ______ ft. at ______ hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? ______ Yes ______ No
If yes, how? ______

12. WELL LOG

Depth (ft.) From	To	Formation
0	0.5	Soil, organic-rich
0.5	3	Fine-med. sand, some clay
3	9	Sandy clay, brn
9	13	Sand med→fine, less clay
13	13.5	sandy clay
13.5	17.1	Micaceous Sandy clay

PA

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 7/22/92

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/1/92
Date

MONTANA TECH
Firm Name
W. PARK ST., BUTTE, MT 59701
Address
Jol Sonderegger MWC-016
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

RECEIVED
AUG 04 1992

#8

m No. 603 (Rev. 7/76)

BUTTE

STATE OF MONTANA

093 03N 08W 25 SILVER BOW

Department of Natural Resources and Conservation

WELL LOG REPORT

File No. 24429

RECEIVED

SEP 1 7 1979

MONT. DEPT. OF NATURAL

Copy in file

White-Department

026488

Gold-Driller

State law requires that this form be filed by the water well driller within 60 days after completion of the well, and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

. WELL OWNER

Name Stanford Dugdale

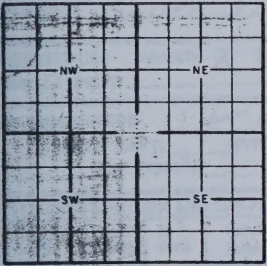
N

2. CURRENT MAILING ADDRESS

Dugdale Construction Co., Inc.
4 1/2 Mile Vue, Butte, MT 59701

. PROPOSED USE x domestic (includes lawn and garden); ____ stock; ____ municipal; ____ industrial; ____ irrigation; ____ other (specify) ____

. WELL LOCATION



____ ¼ ____ ¼ ____ ¼ ____ ¼ Section 25

T. 3-North (N or S) R. 8-West (E or W)

OR, Lot ____ Block 2800 Blk

Subdivision South Montana

City Butte County ~~Butte~~-Silver Bow

Elevation ____ Accuracy: __ ±10'; __ ±50'; __ ±100';

. DRILLING METHOD ____ cable, ____ bored, x forward rotary, ____ reverse rotary, ____ jetted, ____ other (specify) ____

. WELL CONSTRUCTION AND COMPLETION

e of lled le	Size and weight of casing	From (feet)	To (feet)	Perforations ____ and/or Screen ____ Kind Size	From (feet)	To (feet)
6"	6 5/8" od x .250	+2'	13'			
	4" PVC 200#	10'	400'	Skill Saw	380'	400'

Was casing left open end? x Yes, ____ No

Was a packer or seal used? ____ Yes, x No

If so, what material ____

Was the well gravel packed? ____ Yes, x No

Was the well grouted? ____ Yes, x No

To what depth? ____

Material used in grouting ____

Well head completion: Pitless adapter 12 in. above grade ____, other ____ (if other, specify) ____

Pump horsepower ____, pump type ____

Pump intake level ____ feet below land surface

Power (electric, diesel, etc.) ____

7. WATER LEVEL

Static water level ____ feet below land surface

If flowing, closed-in pressure ____ psi

____ gpm flow through ____ inch pipe

Controlled by: ____ valve, ____ reducers, ____ other (if other, specify) ____

8. WELL TEST DATA ____ pump ____ bailer X other (if other, specify) air compressor

Pumping level below land surface:

____ ft. after ____ hrs. pumping 40 gpm

____ ft. after ____ hrs. pumping ____ gpm

9. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No

If yes, how? ____

10. DATE STARTED 7/25/79

DATE COMPLETED 7/27/79

11. WELL LOG

Depth (ft.) From	To	Formation
0'	15'	Decomposed granite
15'	100'	Rock
100'	125'	Decomposed granite
125'	150'	Clay
150'	400'	Rock
		Dan O'Keefe

(use separate sheet if necessary)

12. DRILLER'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/21/79
Date

O'Keefe Drilling Company
Firm Name

P.O. Box 3830, Butte, MT 59701
Address

Ed O'Keefe
Signature Ed O'Keefe

287
License No.

Butte 093 03N 08W 25 A Silver Bow #9

Form No. 603 R2/81

File No. ____

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after comple

026489

1. **WELL OWNER**
Name Doug Rosholt

2. **CURRENT MAILING ADDRESS**
5100 Warren Ave
Butte Montana 59701

3. **WELL LOCATION**
County Silver Bow
Township 3 [✓ N]/S Range 8 E/[✓ W]
¼ ¼ NE ¼ Section 25
Lot #9 Block 34
Subdivision South Park

4. **PROPOSED USE** Domestic ☒ Stock ☐ Irrigation ☐
Other ☐ specify ____

5. **DRILLING METHOD** [✓ cable], ____ bored, ____ forward rotary, ____ reverse rotary, ____ jetted, ____ other (specify) ____

6. **WELL CONSTRUCTION AND COMPLETION**

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations and/or Screen: Kind Size	From (feet)	To (feet)
7"	6 5/8 18#	+1	83½			

Was casing left open end? [✓ Yes] ____ No
Was a packer or seal used? ____ Yes [✓ No]
If so, what material ____
Was the well gravel packed? ____ Yes [✓ No]
Was the well grouted? ____ Yes [✓ No]
To what depth? ____
Material used in grouting ____
Well head completion: Pitless adapter
[✓ Yes] ____ No
Top of casing 12 in. or greater above grade
[✓ Yes] ____ No

7. **WHAT IS THE TEMPERATURE OF THE WATER?**
45 Degrees Fahrenheit
☐ Measured ☒ Estimated

8. **WATER LEVEL**
Static water level 25 feet below land surface
If flowing; closed-in pressure ____ psi
____ gpm
Controlled by: ____ valve, ____ reducers, ____ other, (specify) ____

9. **WELL TEST DATA** ____ pump [✓ bailer]
____ other, (specify) ____
Pumping level below land surface:
63 ft. after 2 hrs. pumping 20 gpm
____ ft. after ____ hrs. pumping ____ gpm

10. **WAS WELL PLUGGED OR ABANDONED?** ____ Yes [✓ No]
If yes, how? ____

11. **DATE COMPLETED** 8-6-83.

12. **WELL LOG**

Depth (ft.) From	To	Formation
0	15	sandy clay
15	25	sand
25	70	sandy clay
70	75	fine sand
75	80	coarse sand
80	84	hard coarse sand

MBMG-MCMST
DIRECTOR'S OFFICE
AUG 30 1983
FORWARD
Abercrombie James
Bartholomew Miller
Dunstan
Copy: D.O. Files

(use separate sheet if necessary)

13. **DRILLER'S CERTIFICATION**
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8-9-83
Date

Dynamite Drilling
Firm Name

3015 Moulton
Address

Gerald H. Brothers 431
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC

32 SOUTH EWING HELENA, MONTANA 59620 449-3962

artcraft printers of missoula

DEPARTMENT COPY

Butte

03N 08W 25 AB

Silver Bow

088511

#10

WELL LOG REPORT

1. WELL OWNER
Name DAN LLOYD

2. CURRENT MAILING ADDRESS
2637 S. COLORADO
BUTTE, MT 59701

3. WELL LOCATION 2637 S. COLORADO
County SILVER BOW
Township 3 [✓ N]/S Range 8 E/[✓ W]
NW 1/4 NE 1/4 SECTION 25
Lot________ Block________
Subdivision Portion Butte Placer
Tract Number________

4. PROPOSED USE Domestic X
Irrigation ____ Stock ____
Other: ____

5. DRILLING METHOD X Cable
Rotary: ____ Air ____ FWD ____ Reverse
____ Jetted ____ Other :____

6. WELL LOG

From	To	Formation
0	2	Top Soil
2	12	DECOMPOSED GRANITE SAND
12	63	TAN CLAY WITH SAND SEAMS
63	70	FINE SAND WITH MICA
70	80	MED TO COARSE SAND, WATE

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	80

COMPLETIONS
perforations______ screen______

Kind	From feet	To feet
Torch	71	78

Was casing left open?	NO
Was a packer/seal used?	NO
Well gravel packed?	NO
To What depth Well grouted?	18 FT
Grouting Material:	Bentonite Crumbles
Well head completion : Pitless adapter	NO
Top of casing 18" or greater above grade	YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A.	Air ____ Pump X Bailer	____
B.	Static Water Level before:	30 FT
	If flowing closed in pressure ____ PSI ____ GPM	
	Controlled by:	
C.	Depth of Pump for Test	70 FT
D.	Pumping Rate & Discharge	30 GPM
E.	Maximum Drawdown for test	7 FT
F.	Duration of test:	
	Pumping time:	2 HRS.
	Recovery Time:	0.5 HRS.
G.	Recovery Water Level	30 FT
	Time after pumping recovery water data was taken	0.5 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED MAY 15, 1992

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date: May 18, 1992

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702

MWWD 15
Signature License No.
W.F.KENTFIELD

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

PA

M:127645

FORM No. 603 New 7-73 File No. # 11

VISITED: 11/15/79
MAP: BUTTE SOUTH NE 7.5'

STATE OF MONTANA
Department of Natural Resources and Conservation

WHITE -
PINK -
CANARY
GOLDENROD — DRILLER

058163

RECEIVED
JUL 22 1974
Montana Bureau of Mines
2800 HANSON ROAD

WELL LOG REPORT

State law requires that this form be filed by the water well driller on any water well completed by him on and after July 1, 1973 within sixty (60) days after completion of the well.

1. WELL OWNER: Name Kenneth Deap Address ~~[illegible]~~., Butte, Montana

2. WELL LOCATION: County Silver Bow; SE corner of portion of Bottle Placer ___¼ ___¼ ___¼, Sec.___, Twp.___ N-S, Rg.___ E-W

3. PROPOSED USE: X Domestic ___ Stock ___ Municipal ___ Industrial ___ Lawn and Garden ___ Irrigation ___ Other (*if other, specify*)___

4. METHOD DRILLED: x Cable ___ Bored ___ Forward Rotary ___ Reverse Rotary ___ Jetted ___ Other (*if other, specify*)___

5. WELL CONSTRUCTION:
Diameter of hole 6 inches. Depth 45 ft.
Casing: x Steel ___ Plastic ___ Concrete ___ Threaded ___ Welded ___ Other (*if other, specify*)
Pipe Weight: Dia.: From: To:
47 lb/ft 6 5/8 inches +2 feet 45 feet
___ lb/ft. ___ inches ___ feet ___ feet
___ lb/ft. ___ inches ___ feet ___ feet
Was perforated pipe used? X Yes ___ No
Length of pipe perforated 5 feet
Was casing left open end? X Yes ___ No
Was a well screen installed? ___ Yes X No
Material ___ Dia. ___ inches
(*stainless steel, bronze, etc.*)
Perforation type: X slots ___ holes
Size 1/8" set from 38 feet to 43 feet
Size ___ set from ___ feet to ___ feet
Size ___ set from ___ feet to ___ feet
Was a packer or seal used? ___ Yes x No
If so, what material ___
Well type: ___ Straight screen ___ Graveled
Was the well grouted? ___ Yes x No
To what depth? ___ feet
Material used in grouting ___
Well head completion: Pitless adapter ___
12" above grade ___ Other ___
(*If other, specify*) ___
Was the well disinfected? X Yes ___ No

6. WATER LEVEL:
Static water level 14 ft. below land surface
If flowing: closed-in pressure ___ psi
GPM flow ___ through ___ inch pipe
Controlled by: ___ Valve ___ Reducers
___ Other, *specify* ___

7. WELL TEST DATA: ___ Pump X Bailer ___ Other
(*If other, specify*) ___
Pumping level below land surface:
___ ft. after 2 hrs. pumping 10 gpm
___ ft. after ___ hrs. pumping ___ gpm

8. WELL LOG:

Depth (ft.)		
From	To	Formation
0'	11'	Decomposed sand & clay
11'	19'	Decomposed sand - seepage
19'	33'	Dirty sand & gravel, wate
33'	38'	Sand & clay
38'	45'	Decomposed granite - wate

(*Use separate sheet if necessary*)

9. DATE STARTED: August 16, 1973

10. DATE COMPLETED: August 18, 1973

11. WAS WELL PLUGGED OR ABANDONED? ___ Yes v No
If so, how ___

12. DRILLER'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

O'Keefe Contracting Company 008
Driller's or Firm Name *License No.*

2804 Harvard Avenue, Butte, Montana
Address

Signed by 8/22/73 *Date*

Vh

Butte 083 3N 8W 25 BA

RECEIVED
AUG 1 1991
MONTANA DNRC
HELENA FIELD OFFICE

Silverbow
#12

081926

WELL LOG REPORT

1. WELL OWNER
Name Mount Moriah Cementary

2. CURRENT MAILING ADDRESS
South Montana Street
Butte MT 59701

3. WELL LOCATION Well #8
County Silverbow
Township 3 N Range 8 W
NE 1/4 NW 1/4 SECTION 25
Lot________ Block________
Subdivision________
Tract Number________

4. PROPOSED USE Domestic ________
Irrigation ________ Stock________
Other: Sprinkling________

5. DRILLING METHOD X Cable
Rotary______ Air ______ FWD ______ Reverse
______ Jetted______ Other:________

6. WELL LOG

From	To	Formation
0	5	Top Soil
4	35	Sandy Clay
35	48	Sand
48	56	Gravel & Water

PA: drainage

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date:

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702

Lee Lock 29
Signature License No.
Lee Lock

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	58

COMPLETIONS
perforations________ screen________

Kind	From feet	To feet
Torch	48	56

Was casing left open?	NO
Was a packer/seal used?	NO
Well gravel packed?	NO
To What depth Well grouted?	21 FT
Grouting Material:	Bentonite Crumbles
Well head completion :	
Pitless adapter	NO
Top of casing 18" or greater above grade	YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air ______ Pump X Bailer ______
B. Static Water Level before: 25 FT
If flowing closed in pressure
______ PSI ______ GPM
Controlled by:
C. Depth of Pump for Test 50 FT
D. Pumping Rate & Discharge 40 GPM
E. Maximum Drawdown for test 30 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 1 MIN
G. Recovery Water Level 25 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED June 6 1991

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M·123312

Butte 093 3N 8W 25 BA RECEIVED Silverbow

AUG 1 1991

#13

MONTANA DNRC
HELENA FIELD OFFICE

081925

WELL LOG REPORT

1. WELL OWNER

Name Mount Moriah Cementary

2. CURRENT MAILING ADDRESS

South Montana Street
Butte MT 59701

3. WELL LOCATION Well #7

County Silverbow
Township 3 N Range 8 W
NE 1/4 NW 1/4 SECTION 25
Lot______ Block______
Subdivision______
Tract Number______

4. PROPOSED USE Domestic X
Irrigation ______ Stock______
Other: Sprinkling

5. DRILLING METHOD X Cable
Rotary____ Air ____ FWD ____ Reverse
____ Jetted____ Other:______

6. WELL LOG

From	To	Formation
0	4	Top Soil
4	30	Sandy Clay
30	41	Sand
41	50	Gravel & Water

PA = drainage

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	51

COMPLETIONS
perforations______ screen______

Kind	From feet	To feet
Torch	41	49

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA

All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air ____ Pump X Bailer ____
B. Static Water Level before: 20 FT
If flowing closed in pressure
____ PSI ____ GPM
Controlled by:
C. Depth of Pump for Test 40 FT
D. Pumping Rate & Discharge 70 GPM
E. Maximum Drawdown for test 35 FT
F. Duration of test:
Pumping time: 2 HRS.
Recovery Time: 1 MIN
G. Recovery Water Level 20 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED June 6 1991

11. DRILLER/CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date:

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702

Lee Lock 29
Signature License No.
Lee Lock

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M:122211

Butte 095 3N08W25 DA SILVER BOW

070101

# 14

WELL LOG REPORT

1. WELL OWNER
Name Mount Moriah Cemetery

2. CURRENT MAILING ADDRESS
South Montana Street
Butte MT 59701

NW Qtr. Sect.
25

3. WELL LOCATION
County Silverbow
Township 3 NORTH N/S Range 8 ~~E~~/W
NE 1/4 SE 1/4 SECTION 25
Lot ______ Block ________________
Subdivision ________________
Tract Number ________________

4. PROPOSED USE Domestic ________
Irrigation __________ Stock __________
Other: Sprinkling ______ X __________

5. DRILLING METHOD X Cable
Rotary ______ Air ______ FWD ____ Reverse
______ Jetted _____ Other: ______________

6. WELL LOG

From	To	Formation
0	3	Top Soil
3	18	Sandy Clay
18	20	Rock
20	44	Sand
44	54	Gravel & Water

DRAINAGE = PA

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	55

COMPLETIONS
perforations ________ screen ________

Kind	From feet	To feet
Torch	45	54

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 24 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air ___ Pump ___ Bailer X
B. Static Water Level before: 20 FT
If flowing closed in pressure
______ PSI _____ GPM
Controlled by:
C. Depth of Pump for Test bailer FT
D. Pumping Rate & Discharge 60 GPM
E. Maximum Drawdown for test 25 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 1 MIN
G. Recovery Water Level 20 FT
Time after pumping recovery water data was taken 0.5 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED June 7 1990

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: June 11, 1990

O'Keefe Drilling Company
P.O. Box 3810 - 2000 Four Mile Road
Butte, MT. 59702

_________________ 29WWD
Signature License No.
Lee Lock

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M;120327

Butte 093 3N08W25BA Silver Bow

078714

#15

WELL LOG REPORT

1. WELL OWNER
Name Mount Moriah Cemetery

2. CURRENT MAILING ADDRESS
South Montana Street
Butte MT 59701

3. WELL LOCATION Well #2
County Silverbow
Township 3 N Range 8 W
NE 1/4 NW 1/4 SECTION 25
Lot__________Block__________________
Subdivision__________________________
Tract Number_________________________

4. PROPOSED USE Domestic ________
Irrigation __________Stock___________
Other: Sprinkling_______________

5. DRILLING METHOD X Cable
Rotary_____Air____FWD ____Reverse
______Jetted_____Other:_____________

6. WELL LOG

From	To	Formation
0	5	Top Soil
5	21	Gravel
21	50	Sandy Clay
50	66	Orange Clay
66	75	Brown Clay
75	80	Decomposed Granite
80	85	White Clay
85	86	Solid Granite

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	88

COMPLETIONS
perforations_________screen_________

Kind	From feet	To feet
Torch	86	90

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 31 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater
above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air _____Pump _____Bailer X
B. Static Water Level before: 40 FT
If flowing closed in pressure
_____PSI _____GPM
Controlled by:
C. Depth of Pump for Test bailer FT
D. Pumping Rate & Discharge 6 GPM
E. Maximum Drawdown for test 84 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 1 HRS.
G. Recovery Water Level 40 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED June 15, 1990

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: June 18, 1990

O'Keefe Drilling Company
P.O. Box 3810 - 2000 Four Mile Road
Butte, MT. 59702

Signature License No. 29
Lee Lock

Drainage = PA

Mi 120999

~~Butte~~ Dillon

093 3N 8W 25 BA Silver Bow

RECEIVED
JUN 28 1991 #16
MONT. DEPT. of NATURAL
OURCES & CONSERVATIO

081655

WELL LOG REPORT

1. WELL OWNER
Name Mount Moriah Cementary

2. CURRENT MAILING ADDRESS
South Montana Street
Butte MT 59701

3. WELL LOCATION Well #6
County Silverbow
Township 3 N Range 8 W
NE 1/4 NW 1/4 SECTION 25
Lot__________ Block__________
Subdivision__________
Tract Number__________

4. PROPOSED USE Domestic ________
Irrigation ________ Stock________
Other: Sprinkling________

5. DRILLING METHOD X Cable
Rotary X Air X FWD ____ Reverse
______ Jetted_____ Other:________
To 100' w/ Cable Tool

6. WELL LOG

From	To	Formation
0	3	Top Soil
3	20	Sand
20	50	Sandy Clay
50	54	Clay
54	58	Gravel & Water
58	61	Clay
61	65	Gravel & Water
65	75	Fine Sand
75	95	Rock w/ Clay Mix
95	100	Sand
100	205	Decomposed Granite

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date: June 26 1991

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702
Lee Lock 29
Signature License No.
Lee Lock

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	100
4"	PVC Casing	90	205

COMPLETIONS
perforations________ screen________

Kind	From feet	To feet
Skill Saw	150	205

Was casing left open?	NO
Was a packer/seal used?	NO
Well gravel packed?	NO
To What depth Well grouted?	21 FT
Grouting Material:	Bentonite Crumbles

Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air _____ Pump X Bailer _______
B. Static Water Level before: 150 FT
If flowing closed in pressure
______ PSI ______ GPM
Controlled by:
C. Depth of Pump for Test 190 FT
D. Pumping Rate & Discharge 40 GPM
E. Maximum Drawdown for test 180 FT
F. Duration of test:
Pumping time: 2 HRS.
Recovery Time: 5 MIN
G. Recovery Water Level 150 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED June 24 1991

MONTANA DEPARTMENT OF NATURAL RESOURCES

PA= DR. BASIN

Form No. 603 R2/81

MAY 06 1983
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

File No. 055587

#17

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

C052841-76b

1. WELL OWNER
Name John WULF

2. CURRENT MAILING ADDRESS
202 E. GREENWOOD Ave.
Butte, MONTANA 59701

3. WELL LOCATION
County
Township 3N N/S Range 8W E/W
NW ¼ NW ¼ NW ¼ Section 25
Lot Block
Subdivision

4. PROPOSED USE Domestic ☒ Stock ☐ Irrigation ☐
Other ☐ specify

5. DRILLING METHOD ✓ cable, ___ bored, ___ forward rotary, ___ reverse rotary, ___ jetted, ___ other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations and/or Screen: Kind Size	From (feet)	To (feet)
7"	6" 18#	0'	80'			

Was casing left open end? ✓ Yes ___ No
Was a packer or seal used? ___ Yes ✓ No
If so, what material
Was the well gravel packed? ___ Yes ✓ No
Was the well grouted? ✓ Yes ___ No
To what depth? 20'
Material used in grouting puddel CLAY
Well head completion: Pitless adapter ✓ Yes ___ No
Top of casing 12 in. or greater above grade ✓ Yes ___ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
45° Degrees Fahrenheit
☐ Measured ☒ Estimated

8. WATER LEVEL
Static water level 10' feet below land surface
If flowing; closed-in pressure ___ psi
___ gpm
Controlled by: ___ valve, ___ reducers, ___ other, (specify)

9. WELL TEST DATA ___ pump ✓ bailer
___ other, (specify)
Pumping level below land surface:
25 ft. after 3 hrs. pumping 25 gpm
___ ft. after ___ hrs. pumping ___ gpm

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes ✓ No
If yes, how?

11. DATE COMPLETED 4-30-83

12. WELL LOG

From	To	Formation
0	4'	TOP SOIL
4	20'	SANDY CLAY
20	65	SAND
65	70	FINE SANDY CLAY
70	78	COARSE SAND
78	80	SAND & GRAVEL - WATER

(use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date 4-30-83
Firm Name DYNAMITE DRILLING
Address 3015 Moulton Butte Mont.
Signature Gerald H. Brothers License No. 431

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION **DNRC**
32 SOUTH EWING HELENA, MONTANA 59620 449-3962

artcraft printers of missoula

DEPARTMENT COPY

(1) 093 T 03N R 08W 23 D

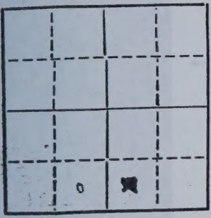
County SILVER BOW

#26

058183

MONTANA BUREAU OF MINES AND GEOLOGY
Butte, Montana

WATER WELL LOG



Owner New Butte Butchering Co. Address Butte Montana

Driller C. J. Noble Address PO Box 170
Anaconda Mont.

Date Started .... Date Completed ....

Location: Sec. .... T. .... R. .... ¼ sec. ....

Type of well Drilled (Dug, driven, bored, or drilled) Equipment used Churn drill (Churn drill, rotary, other)

Water use: Domestic ☐ Municipal ☐ Stock ☐ Irrigation ☐

Industrial ☒ Fire protection Drainage ☐ Other: ....

Casing Surface ft. to 77½ ft. Type Standard Size 8"

Casing: .... ft. to .... ft. Type .... Size ....

Casing: .... ft. to .... ft. Type .... Size ....

Perforated or Screened: Ft. 40 to ft. 77½ Ft. .... to ft. ....

Type of screen or perforations 3/16" x 3" slots

Static Water level, for non-flowing well: 18 feet.

Shut-in pressure, for flowing well: .... lb./sq. in. on: .... (date)

Pumping water level 67 feet at 28 gal. per min.

How tested: Bail checked and pumped with air compresser 140 hrs.

Length of test ....

Remarks: (Gravel packing, cementing, packers, type of shut-off, depth of shut-off)

Hole is drilled 10" to 77½ ft. Lined with 8" cassing. Gravel packed outside 8" to within 17' of surface. Conercated from 17' to surface.

GEO: 110ALVM PA

(over)

GW 4

File No.................

TRIPLICATE

(3) 093 T. 3N R. 8W 24 Cf

County Silver Bow

058184

#27

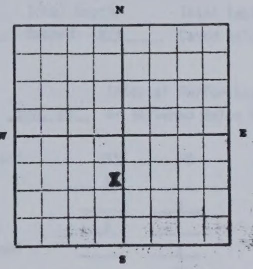
RECEIVED
APR 2 1962
Montana Bureau of
Mines and Geology

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Declaration of Vested Groundwater Rights

(Under Chapter 237, Montana Session Laws, 1961)

1. The Montana Power Company, of 40 East Broadway Butte
(Name of Appropriator) (Address) (Town)
County of Silver Bow State of Montana
have appropriated groundwater according to the Montana laws in effect prior to January 1, 1962, as follows:



NE ¼ SW¼ Sec. 24 T. 3N R. 8W

Indicate point of appropriation and place of use, if possible. Each small square represents 10 acres.

2. The beneficial use on which the claim is based Industrial

3. Date or approximate date of earliest beneficial use; and how continuous the use has been Continuous since 1896

4. The amount of groundwater claimed (in miner's inches or gallons per minute) 50 gallons per minute - 24 hours a day

5. If used for irrigation, give the acreage and description of the lands to which water has been applied and name of the owner thereof

6. The means of withdrawing such water from the ground and the location of each well or other means of withdrawal Well

7. The date of commencement and completion of the construction of the well, wells, or other works for withdrawal of groundwater 1896

8. The depth of water table 10'

9. So far as it may be available, the type, size and depth of each well or the general specifications of any other works for the withdrawal of groundwater
20' - 5' casing
10' - 15" casing

10. The estimated amount of groundwater withdrawn each year 26,280,000 gallons

11. The log of formations encountered in the drilling of each well if available Sand and gravel formation

12. Such other information of a similar nature as may be useful in carrying out the policy of this act, including reference to book and page of any county record

(CORPORATE SEAL)
Attest:

Its Secretary

THE MONTANA POWER COMPANY
Signature of Owner By
Vice President
Date February 1, 1962

Three copies to be filed by the owner with the County Clerk and Recorder of the county in which the well is located.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

Original to the County Clerk and Recorder; duplicate to the State Engineer; Triplicate to the School of Mines and Quadruplicate for the Appropriator.

Butte

3NO8W24 DBB

SilVER BOW

086420

TEST HOLE LOG

State: Montana County: Silver Bow Project: SBC CERCLA Hole Name or Number: A1-GS-GW-29S #28

Legal Location: T 3N R 8W Sec 24 Tract DBB Descriptive Location: 70' N of MSD; 100' E of RR bridge over MSD

Recorded By: ME Hole Started: Time: 1530 Date: 07/07/89 Hole Completed: Time: ____ Date: 07/08/89 Driller: Butch Drilling Company: CNI

Drill Method: Auger Drilling Fluids Used: N/A Pilot Hole Diameter: 9" Reamed Hole Diameter: N/A

Total Depth Drilled: 13.5' Total Depth Reamed: N/A Total Depth Cased Below G.S.: 13' Diameter and Type of Casing: 2" Flush Threaded PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 8.0-13.0' Target Aquifer: Alluvium Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	X	
Well Test Pumped?		X
Water Samples Taken?	X	
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened
- ___ No casing in hole
- ___ Open bottom
- ___ Slotted with Mill's Knife
- ___ Slotted with a torch
- ___ Screened by pulling casing
- ___ Field saw cut Hacksaw
- ___ Mechanical slots ____ (size)
- X Other (specify) Factory .02

Static Water Level: 4.80' Date/Time Measured: 8/23/89

Measuring Point Description/Elevation: Top of steel (N side) 5443.26' MP Height Above (+/-) or Below G.S.: + 2.29'

Well Annulus Completion Description: 10-20 Colorado Silica Sand 6.5-13.5'; 1/4" Bentonite pellets 5.5-6.5'; Pure Gold grout 0-5.5'; concrete with locked steel well head protector.

Remarks:

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1.75	Sandy, minor pebbles tailings; Yellow orange to light brown.
1.75	7	Minor clay, silty sand; Dark gray. Water at 6'.
7	13.5	Minor clayey, silty, sandy, cobbley fill; Dark gray fines; <200 - 30%

7A

Butte 093 3N8W 24 CC

RECEIVED
AUG 1 1991
MONTANA DNRC
HELENA FIELD OFFICE

#29
Silverbow
081924

WELL LOG REPORT

1. WELL OWNER
Name Town Pump

2. CURRENT MAILING ADDRESS
600 South Main
Butte MT 59701

3. WELL LOCATION South Montana St
County Silverbow
Township 3 N Range 8 W
SW 1/4 SE 1/4 SECTION 24
Lot ______ Block ______
Subdivision ______
Tract Number ______

4. PROPOSED USE Domestic ______
Irrigation ______ Stock ______
Other: Store

5. DRILLING METHOD X Cable
Rotary ______ Air ______ FWD ______ Reverse
______ Jetted ______ Other: ______

6. WELL LOG

From	To	Formation
0	12	Sand
12	35	Clay
35	41	Sandy Clay
41	48	Gravel & Water

PA = drainage

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	50

COMPLETIONS
perforations ______ screen ______

Kind	From feet	To feet
Torch	42	48

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air ______ Pump ______ Bailer X
B. Static Water Level before: 20 FT
If flowing closed in pressure
______ PSI ______ GPM
Controlled by:
C. Depth of Pump for Test bailer FT
D. Pumping Rate & Discharge 20 GPM
E. Maximum Drawdown for test 25 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 1 MIN
G. Recovery Water Level 20 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED October 22 1990

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: 09-Nov-90

O'Keefe Drilling Company
P.O. Box 3810 - 2000 Four Mile Road
Butte, MT. 59702

Lee Lock
Signature License No. 29
Lee Lock

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M:123304

utte 3N08W24DDB SILVER BOW

086421

TEST HOLE LOG

State: Montana County: Silver Bow Project: SBC CERCLA Hole Name or Number: A1-GW-GS-29D #30

Legal Location: T 3N R 8W Sec 24 Tract DDB Descriptive Location: 70' North of MSD, 100' East of railroad bridge over MSD

Recorded By: TG Hole Started: Time: ____ Date: 07/25/89 Hole Completed: Time: ____ Date: 07/26/89 Driller: Loch WWD 029 Drilling Company: O'Keefe

Drill Method: Cable Tool Drilling Fluids Used: N/A Pilot Hole Diameter: 6" Reamed Hole Diameter: N/A

Total Depth Drilled: 40' Total Depth Reamed: N/A Total Depth Cased Below G.S.: 39.6' Diameter and Type of Casing: 2" Flush Threaded PVC

Weight or Gage of Casing: Sch.40 Interval Perforated or Screened Below G.S.: 29.6-39.6' Target Aquifer: Alluvium Packer Type and Depth Below G.S.: None

DURING INSTALLATION WAS:	YES	NO
Well Developed?	X	
Well Test Pumped?		
Water Samples Taken?	X	
Material Samples Taken?		
E-Logs?		

Method Perforated or Screened

	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut Hacksaw
	Mechanical slots ____ (size)
X	Other (specify) 0.02" Factory

Static Water Level: 4.85' Date/Time Measured: 8/23/89

Measuring Point Description/Elevation: Top of steel, N side / 5448.22' MP Height Above (+/-) or Below G.S.: + 1.94'

Well Annulus Completion Description: Sand foot 40-39.6', Colorado Silica sand 39.6-27.7'; Bentonite pellets 27.7-26.7'; Enviroplug to surface.

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	15	Dark gray to black sandy gravelly clay. Fines -60% of sample. Sand fraction is rounded to sub-rounded, moderately poorly sorted, moderate sphericity. Larger clasts are angular to sub-angular, low sphericity. Fines contain few micas of Fe clasts. Lithic fragments predominate in large fraction, quartz in smaller. $T = 28^{\circ}$, pH = 5, SC = 940
15	19	Alternating dark gray to black sandy clay/clayey sands, locally color is brown. Fines (<200) -80% of sample, locally T = 30, SC = 780, pH = 6.3, MV = 35; making water at 19'.
19	25	Brown to light brown, well sorted sandy clay. Fines -15%-25% of sample. Clasts coarse grained, sub-rounded to sub-angular with high sphericity. Fines contain 3%-5% Fe clasts. Sand heaving.
25	35	Brown to dark brown moderately poorly sorted clayey sand and gravels. Sand fraction ranges from very fine to very coarse. Medium sand is sub-angular to rounded, moderate sphericity. Sand fraction is ~30% lithics, mostly quartz. Larger clasts are angular to sub-angular, moderately low sphericity, 50% quartz, 50% lithics, pH = 6.7, SC = 1040, T = 30, MV = 2.
35	39	Brown to tan clayey sandy gravel. Sample is poorly to moderately poorly sorted. Sand/silt clasts are rounded to sub-angular, moderately high sphericity, composed primarily of quartz. Larger clasts are angular to sub-angular with low sphericity. Larger clasts predominately quartz with few lithic fragments, little or no micas present. pH = 7.4, SC = 728, $T = 13^{\circ}C$.
39	40	Brown to tan clayey sandy gravel. Coarse fragments up to 1/2" in diameter present. Large clasts are angular to sub-angular with low sphericity. Sand fraction is coarse grained with rounded to sub-rounded, moderately low sphericity. Fines contain lots of micas. pH = 7.2, SC = 966.
		* Bedrock pick = 35'

PA

GW

RECEIVED
JAN 2 1964
Montana Bureau of
Mines and Geology

(4) (4)

058190

Well 1

#31

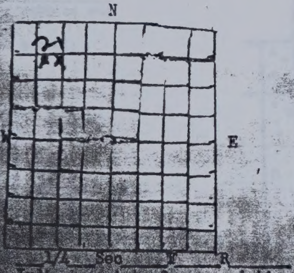
MONTANA

OFFICE OF STATE

- - - - -

OF VESTED GROUNDWATER RIGHTS
Chapter 237, Montana Session Laws, 1961)

1. Mrs Jean & Percy G. Trethewey (Name) of 2623 Oregon Ave (Address) Butte (Town) County of Silver Bow, State of Montana, have appropriated groundwater according to the Montana law in effect prior to January 1, 1962, as follows:



__1/4__Sec____T____R____

Indicate point of appropriation and place of use, if possible. Each small square represents 10 acres.

2. The beneficial use on which the claim is based Domestic & Livestock

3. Date or approximate date of earliest beneficial use; and how continuous the use has been 1900 & continuous

4. The amount of groundwater claimed (in miner's inches or gallons per minute) 24 gallons per min.

5. If used for irrigation, give the acreage and description of the lands to which water has been applied and name of the owner thereof 2 city lots Percy G & Jean Trethewey N.W. Sec 6 T 3 N R 8 W

6. The means of withdrawing such water from the ground and the location of each well or other means of withdrawal Electrical Pump

7. The date of commencement and completion of the construction of the well, wells, or other works for withdrawal of groundwater 1900

8. The depth of water table 10 feet

9. So far as it may be available, the type, size and depth of each well or the general specifications of any other works for the withdrawal of groundwater No 1 Well 30 ft. No 2 well 30 ft.

10. The estimated amount of groundwater withdrawn each year 2 Million

11. The log of formations encountered in the drilling of each well if available Unknown

12. Such other information of a similar nature as may be useful in carrying out the policy of this act, including reference to book and page of any county record

Signature of Owner Jean Trethewey

Date Dec 31, 1963

- - - - -

STATE OF MONTANA)
COUNTY OF SILVER BOW) ss

Jean Trethewey having first been duly sworn, depose___ and say___ that ___he ____ of lawful age and ____________ the appropriator ______ and claimant ____ of the order and water right mentioned in the foregoing declaration of vested groundwater rights and the person____ whose name________ subscribed thereto, as the appropriator___ and claimant_____, that ___he _____ know____ the contents of said foregoing notice and that the matters and things therein stated are true.

Margaret Pond

Subscribed and sworn to before me, this 31 day of Dec 19 62

23 DACBADC Silver Bow INSTRUCTION DIAGRAM
MT 90-2

#1

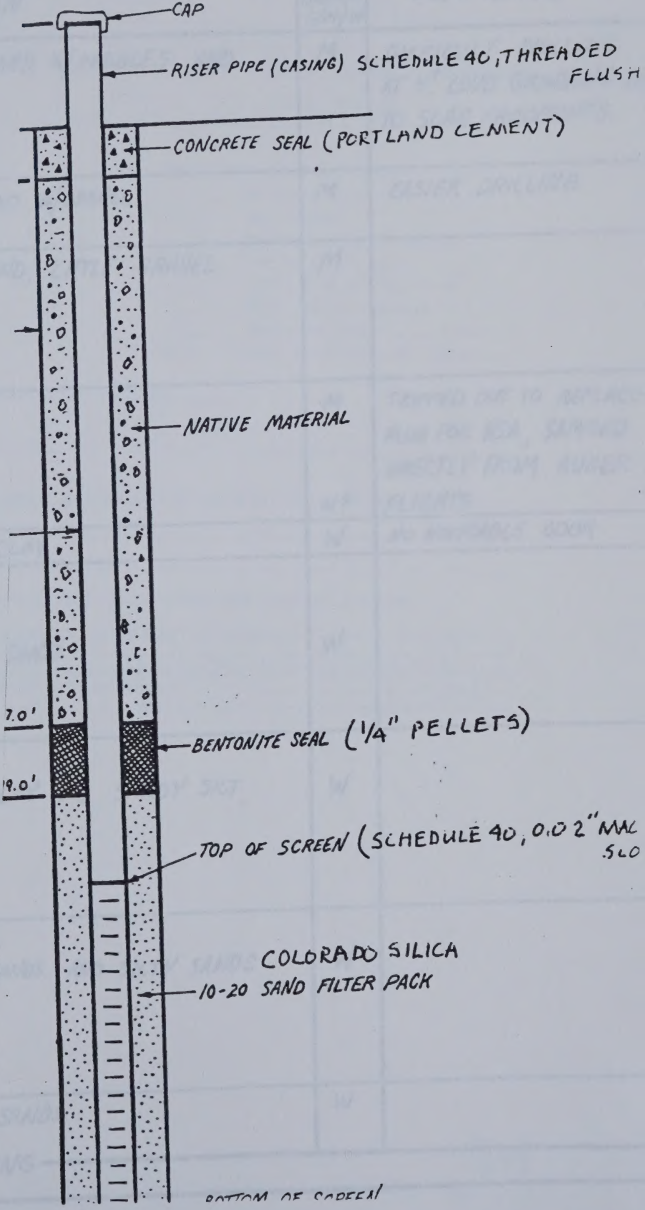
EOLOGY

MBMG IDENTIFICATION NO:

RANGE: 08W SECTION: 23 DACBADC

0	LITHOLOGY
4	coarse brown loamy sand w/ pebbles and cobbles; moist
6	coarse brown loamy sand w/ gravel; moist
10	coarse brown loamy sand, little gravel; moist
14	silty sand, sandy clay; moist to wet
15	dark gray silty organic clay; wet
20	coarse brown silty sand; wet
25	coarse brown sandy clay and sandy silt, some pebbles; wet
30	coarse brown clayey sand and silty sand; wet
32	coarse brown silty sand; wet

uaternary alluvium


CAP
RISER PIPE (CASING) SCHEDULE 40, THREADED FLUSH
CONCRETE SEAL (PORTLAND CEMENT)
NATIVE MATERIAL
7.0'
BENTONITE SEAL (1/4" PELLETS)
19.0'
TOP OF SCREEN (SCHEDULE 40, 0.02" MAC SLO
COLORADO SILICA
10-20 SAND FILTER PACK
BOTTOM OF SCREEN

Drainage = PA

M: 122 706

DRILLING LOG
MT 90-2

DEPTH (FT)	DESCRIPTION	WATER CONTENT D/M/W	COMMENTS
0–4 (1, 2, 3)	COARSE BROWN LOAMY SAND W/PEBBLES AND COBBLES	M	DIFFICULT DRILLING AT 4'. LOUD GRINDING D
			TO SLAG FRAGMENTS
4–6 (5)	COARSE BROWN LOAMY SAND W/GRAVEL	M	EASIER DRILLING
6–10 (7, 8, 9)	COARSE BROWN LOAMY SAND, LITTLE GRAVEL	M	
10–14 (11, 12, 13)	SILTY SANDS, SANDY CLAYS	M W?	TRIPPED OUT TO REPLACE PLUG FOR HSA, SAMPLED DIRECTLY FROM AUGER FLIGHTS
14–15	DARK GRAY SILTY ORGANIC CLAY	W	NO NOTICABLE ODOR
15–20 (16, 17, 18, 19)	COARSE BROWN SILTY SAND	W	
20–25 (21, 22, 23, 24)	COARSE BROWN SANDY CLAY AND SANDY SILT, SOME PEBBLES	W	
25–30 (26, 27, 28, 29)	COARSE BROWN CLAYEY SANDS AND SILTY SANDS	W	
30–32 (31)	COARSE BROWN SILTY SANDS	W	
32	END OF BORING		

Butte

3N 08W 23 DAB

Silver Bow

086412

TEST HOLE LOG

State: Montana County: Silver Bow Project: SBC CERCLA Hole Name or Number: AI-GW-GS-25

Legal Location: T 3N R 8W Sec 23 Tract DAB

Descriptive Location: -35' East of SBC, - 50' South of gate to SBC Gravel Plant, West of Butte STP

Recorded By: PD Hole Started: Time: 1600 Date: 07/06/89 Hole Completed: Time: 1700 Date: 07/06/89 Driller: Butch Drilling Company: CNI

Drill Method: Auger Drilling Fluids Used: None Pilot Hole Diameter: 9" Reamed Hole Diameter: N/A

Total Depth Drilled: 12.5' Total Depth Reamed: N/A Total Depth Cased Below G.S.: 9.5' Diameter and Type of Casing: 2" Flush Threaded PVC

Weight or Gage of Casing: Sch.40 Interval Perforated or Screened Below G.S.: 4.5-9.5' Target Aquifer: Alluvium Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	X	
Well Test Pumped?		X
Water Samples Taken?	X	
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

	No casing in hole
	Open bottom
	Slotted with Mill's Knife
	Slotted with a torch
	Screened by pulling casing
	Field saw cut Hacksaw
	Mechanical slots ______ (size)
X	Other (specify) .02" Factory

Static Water Level: 4.62' Date/Time Measured: 8/24/89

Measuring Point Description/Elevation: Top of steel/N side/5427.76' MP Height Above (+/-) or Below G.S.: + 1.80'

Well Annulus Completion Description: 10-20 Colorado Silica sand 3.0-11.0'; 1/4" Bentonite pellets 2.0'-3.0'; Pure Gold Grout and Bentonite pellets 1.0 to 2.0'

Remarks:

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	0.5	Gravel; angular 1/2" minus crush gravel and fill material
0.5	10.0	Sand, fine to medium, sub-angular sand; moderately well sorted, silt matrix, water at 1.0, sand heaving into augers at - 7.0'.

PA

093 3N 08W 23 DACCAAA Silver Bow

#2 070309

MONTANA BUREAU OF MINES AND GEOLOGY
WELL DATA SHEET

MBMG IDENTIFICATION NO:

Latitude ° ' " N, Longitude ° ' " W TOWNSHIP: 03N RANGE: 08W SECTION: 23 DACCAAA
COUNTY: Silver Bow
USGS 7.5' MAP: Butte South
ALTITUDE LAND SURFACE AT WELL 5435 FT

REPORTED DATA:
TOTAL DEPTH OF WELL BELOW LAND SURFACE 29 FT
PUMPING WATER LEVEL BELOW LAND SURFACE FT
STATIC WATER LEVEL BELOW* LAND SURFACE 7.4 FT
YIELD GPM
HOW TESTED
LENGTH OF TEST (HOURS)

CASING

FROM (FT)	TO (FT)	DIA (IN)	TYPE
+2.47	29	2 OD	PVC

PERFORATIONS

FROM (FT)	TO (FT)	DESCRIPTION
16	25.5	screen schedule 40 0.02 slot

WELL SEAL TYPE: concrete
WELL SEAL DEPTH FROM: 0 ft to 1 ft
WELL SEAL TYPE: bentonite
WELL SEAL DEPTH FROM: 3 to 4 feet
DATE WELL COMPLETED: 23 July 1990
HOW DRILLED: augur
BY WHOM: Willis Weight
LIC NO: MWC-215
WATER USE: monitoring of water levels
SOURCE OF REPORTED DATA: driller

LOG:

FROM	TO	LITHOLOGY
0	4	coarse brown sandy loam gravel to 2" diameter; moist
4	10	coarse dark brown sandy clay and clayey sand, gravel to 2" diameter; moist
10	13	boulders and large cobbles, probably slag
13	14	black silty organic clay, coarse sandy clay; wet
14	15	dark gray coarse silty sand and clay; wet
15	16	dark gray and orange silty clay, micaceous; wet
16	20	coarse brown silty sand and coarse sandy gray clay; wet
20	29	coarse brown silty sand, minor clay; wet

Quaternary alluvium

REFERENCE:
Well Reference No MT 90-1, Colorado Tailing, Butte

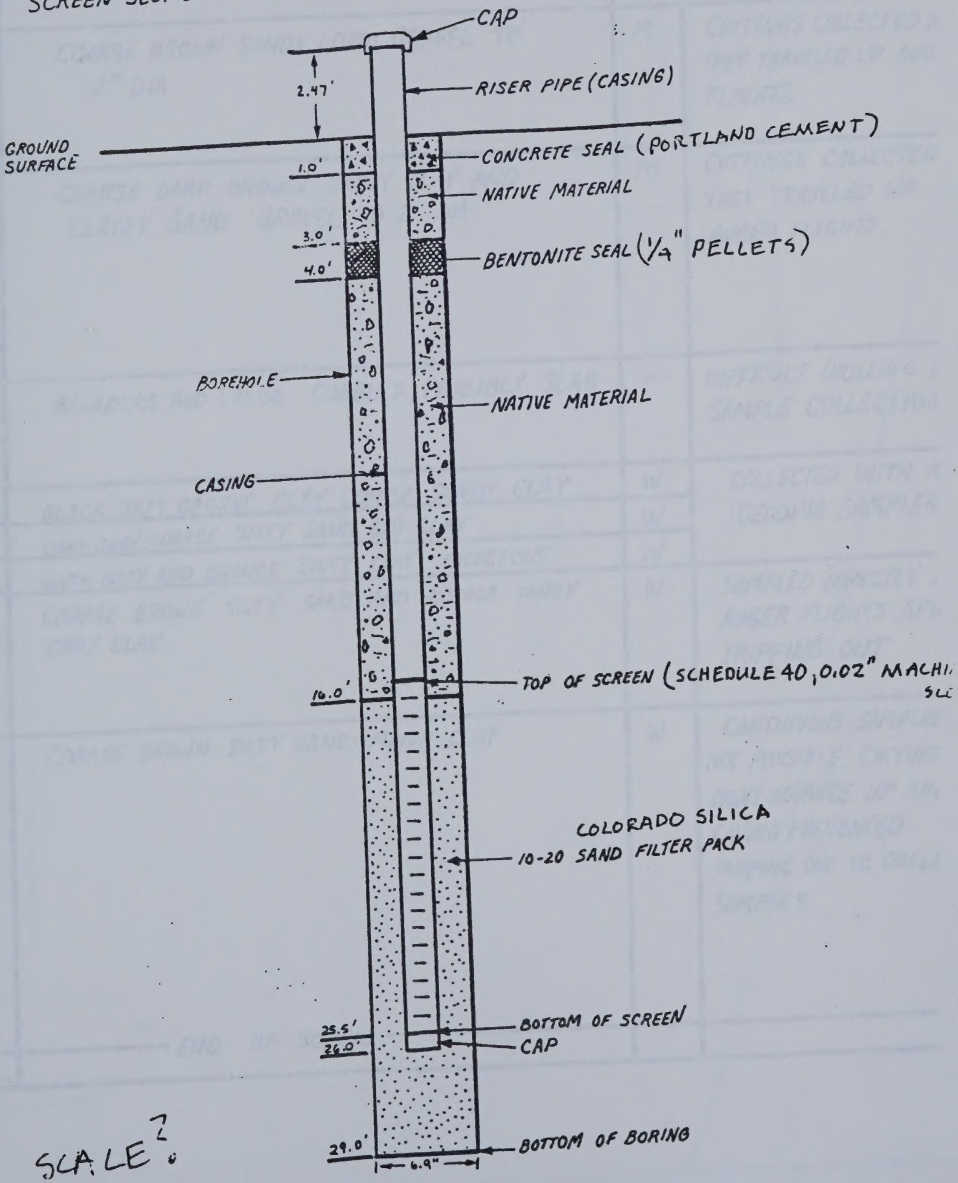
REMARKS:
Well annulus filled with Colorado silica from 15.5 feet to the bottom of the well

Drainage = PA

M:120707

WELL CONSTRUCTION DIAGRAM
MT 90-1

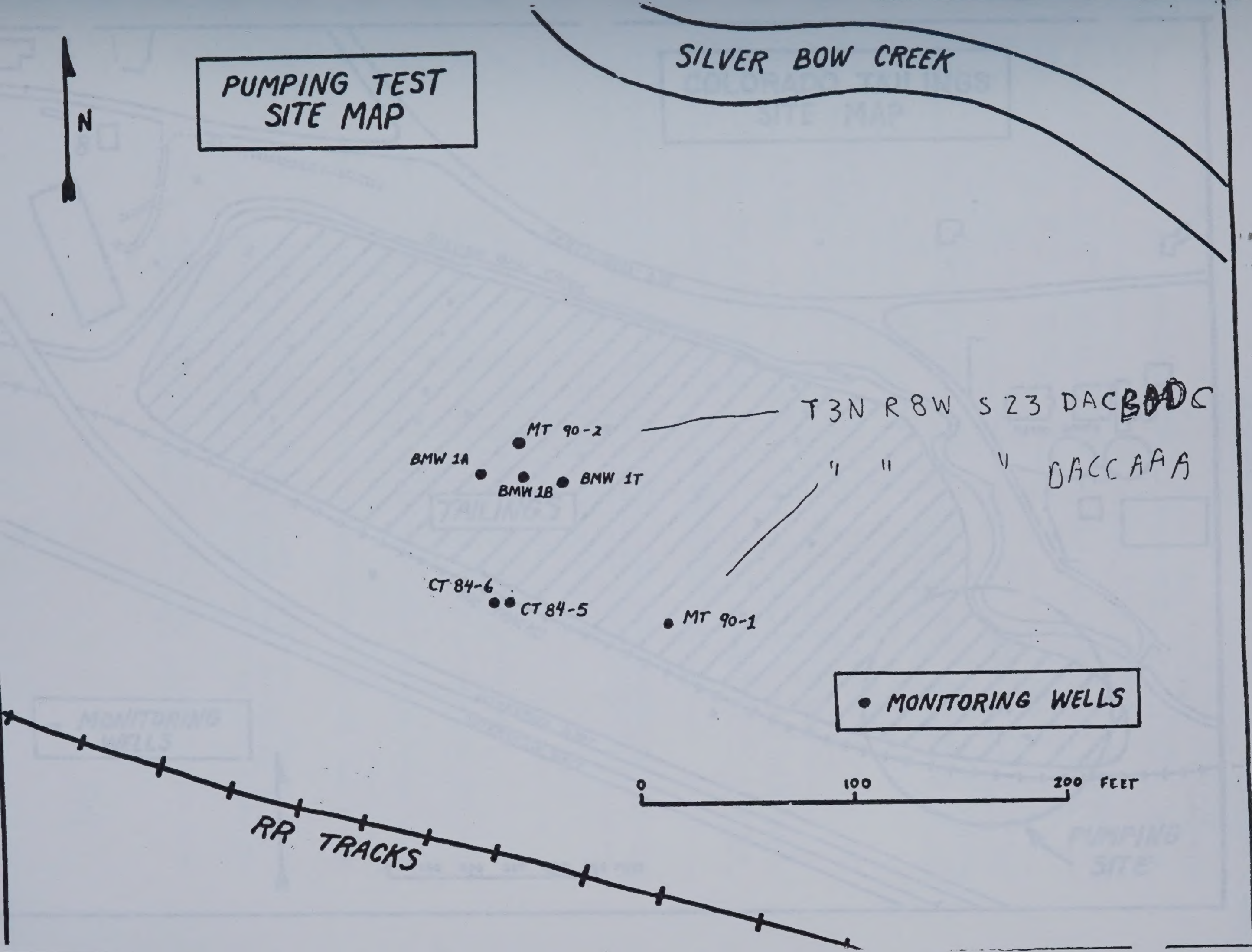
CASING: 2" OD PVC
SCREEN: 2" OD PVC
SCREEN SLOT SIZE: .020"

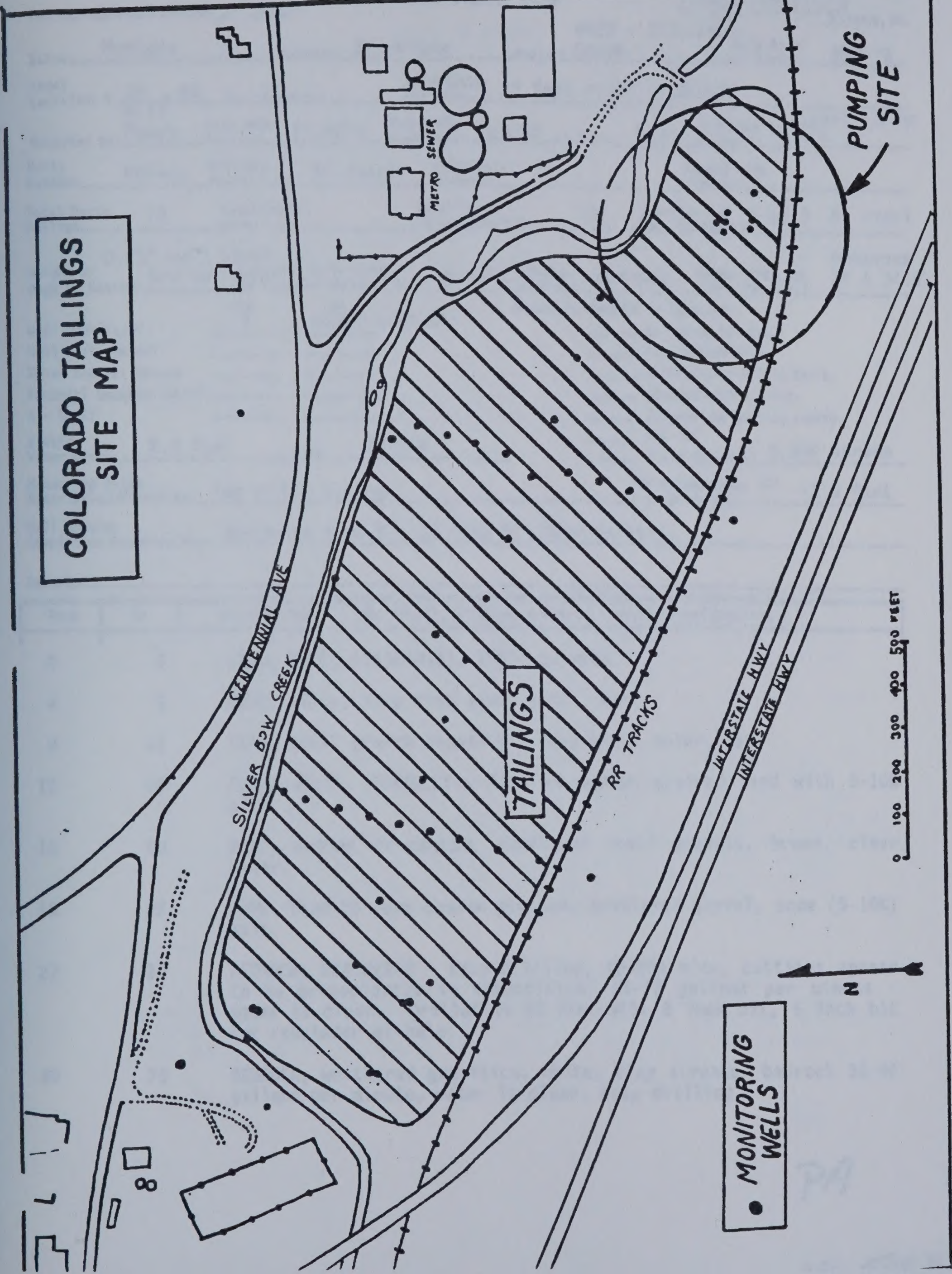

CAP
RISER PIPE (CASING)
2.47'
GROUND SURFACE
CONCRETE SEAL (PORTLAND CEMENT)
1.0'
NATIVE MATERIAL
3.0'
BENTONITE SEAL (1/4" PELLETS)
4.0'
BOREHOLE
NATIVE MATERIAL
CASING
TOP OF SCREEN (SCHEDULE 40, 0.02" MACHI
SL
10.0'
COLORADO SILICA
10-20 SAND FILTER PACK
25.5'
BOTTOM OF SCREEN
26.0'
CAP
29.0'
BOTTOM OF BORING
6.9"

SCALE?

DRILLING LOG
MT-90-1

DEPTH (FT)	DESCRIPTION	WATER CONTENT D/M/W	COMMENTS
1 2 3	COARSE BROWN SANDY LOAM. GRAVEL TO 2" DIA.	M	CUTTINGS COLLECTED THEY TRAVELED UP AUG FLIGHTS.
4 5 6 7 8 9	COARSE DARK BROWN SANDY CLAY AND CLAYEY SAND. GRAVEL TO 2" DIA.	M	CUTTINGS COLLECTED THEY TRAVELED UP AUGER FLIGHTS.
10 11 12	BOULDERS AND LARGE COBBLES, PROBABLY SLAG	—	DIFFICULT DRILLING SAMPLE COLLECTIO
13	BLACK SILTY ORGANC CLAY, COARSE SANDY CLAY	W	COLLECTED WITH A GEDDING SAMPLER
14	DARK GRAY COARSE SILTY SAND AND CLAY	W	
15	DARK GRAY AND ORANGE SILTY CLAY; MICACEOUS	W	
16 17 18 19	COARSE BROWN SILTY SAND AND COARSE SANDY GRAY CLAY	W	SAMPLED DIRECTLY AUGER FLIGHTS AFT TRIPPING OUT
20 21 22 23 24 25 26 27 28	COARSE BROWN SILTY SAND; MINOR CLAY	W	CONTINUOUS SAMPLIN NOT POSSIBLE. CUTTING DIDN'T ADVANCE UP AN CAVING PREVENTED TRIPPING OUT TO COLLE SAMPLES.
29	END OF BORING		

N
PUMPING TEST SITE MAP
SILVER BOW CREEK
MT 90-2
BMW 1A
BMW 1B
BMW 1T
CT 84-6
CT 84-5
MT 90-1
T3N R8W S23 DACBDC
" " " DACCAAA
● MONITORING WELLS
0
100
200 FEET
RR TRACKS


COLORADO TAILINGS SITE MAP
METRO SEWER
PUMPING SITE
CENTENNIAL AVE
SILVER BOW CREEK
TAILINGS
RR TRACKS
INTERSTATE HWY
INTERSTATE HWY
0 100 200 300 400 500 FEET
N
MONITORING WELLS

3N08W24

SILVER BOW

TEST HOLE LOG

HYDROMETRICS

067840

Helena, Mt.

State: Montana
County: Silverbow
Project: ARCO - Silverbow Creek
Hole Name or Number: BMW-7B

Legal Location: T 3N R 8W Sec. 24 Tract
Descriptive Location: 30 feet north of BMW-7A.

Recorded by: Bill Peery
Date Hole Started: 7/19/89
Date Hole Completed: 7/9/89
Driller: Mark
Drilling Company: H & L WWC 334

Drill Method: Rotary
Drilling Fluids Used: Air/water
Pilot Hole Diameter: 8"
Reamed Hole Diameter:

Total Depth Drilled: 72
Total Depth Reamed:
Total Depth Cased Below G.S.: 72
Diameter and Type of Casing: 0-29.5 8" steel

Weight or Gage of Casing: 0.25" wall steel Sch 40 PVC
Interval Perforated or Screened Below G.S.: 37.4-72
Target Aquifer: Bedrock
Packer Type and Depth Below G.S.: neoprene 32 & 34.4

	YES	NO
Well Developed?	X	blown with air
Well Test Pumped?		
Water Samples Taken?		
Material Samples Taken?		
E - Logs?		

Method Perforated or Screened:

	No casing in hole.
	Open bottom only.
	Slotted with Mill's Knife.
	Slotted with a torch.
	Screened by pulling casing.
	Saw cut
X	Other (specify) 0.030 screen

Static Water Level: 2.3 feet
Date: 7/9/89

Measuring Point Description/Elevation: Top of PVC casing
MP Height Above (±) or Below G.S.: +1.3 feet

Well Annulus Completion Description: Bentonite from 0 - 32 (top of upper packer).

Remarks:

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	4	SAND, SILTY (TAILINGS), light colored.
4	9	SAND, silty, very fine sand, soft. Wet.
9	12	CLAY, SILTY (Marsh Deposit) - Gray-black color, wet.
12	16	SAND, SILTY, GRAVELLY - Fine to medium grained sand with 5-10% silt.
16	19	SAND, medium to coarse, scattered small gravels, brown, clear water.
19	27	SAND, fine to very coarse grained, scattered gravel, some (5-10%) silt.
27	39	BEDROCK, WEATHERED - Easy drilling, 20-30% mica, cuttings appear to be granodiorite in composition, 15-17 gallons per minute - water is clear. Drilled to 30 feet with 8 inch bit, 6 inch bit for remainder of hole.
39	70	BEDROCK, weathered granitics, white, clay streaks, bedrock 36-40 gallons per minute, water is clear, easy drilling.

PA

3N08W24

Silver Bow

086416

DAMES & MOORE
Monitoring Well Drilling and Completion Report

Project: ARCO Coal Co./ Colorado Tailings

Well: GS-19C

Legal Location: Sec 24, T3N,R8W, Silver Bow Co., Montana
Descriptive Location: 50' East of Butte Reduction Works Roadcut.
At location of existing well GS-19.

Well Started: 7:50am 07/10/90
Well Completed: 10:00pm 07/11/90

Drilling Contractor: O'Keefe Drilling WWC 287
Drilling Method: Mud rotary to 40', 12" hole.
Air rotary with downhole hammer to 100', 8" hole.

LITHOLOGY

For lithologic description see GS-19D.

DRILLING AND COMPLETION

Drilled 12" hole to 40' using mud rotary. Set 8" steel casing at 40', cemented using tremie, circulated cement to surface. Allowed cement to cure overnight. Drilled 8" hole to 100' using air rotary with downhole hammer. Circulated hole clean, getting formation cavings. Produced water disposed at Butte Reduction Works. Checked bottom with tape, had fillup to 78'. Cannot stop formation caving.

4" PVC Schedule 40 flush thread set at 78', centralizer at 50', Threaded cap on bottom, slip cap at surface, 0.020" slotted screen 65-75'. Gravel pack (10/20 silica sand) 63-78'. Bentonite seal (Holeplug) 56-63'. Allowed seal to yield overnight. Pumped bentonite slurry (Pure Gold AquaGel) using tremie, circulated to surface. Checked water level inside PVC when pumping slurry, did not move. Installed locking steel cap, poured cement pad at surface.

DEVELOPMENT

07/18/90 Set submersible electric pump at approx. 70'. Began pumping 2:55pm. Well stabilized at 9-10 gpm, water level 22', water clear. Last sample 3:50pm, pH 6.71, SC 550 at 12.1 deg C. Gathered sample for laboratory analysis.

PA

M:126150

3 N 08 W 24 CBB

Silver Bow

086419

TEST HOLE LOG

State: Montana County: Silver Bow Project: SBC CERCLA Hole Name or Number: AI-GW-GS-19

Legal Location: T 3N R 8W Sec 24 Tract CBB Descriptive Location: 50' E of Butte Reduction Works Roadcut

Recorded By: PD Hole Started: Time: 1130 Date: 06/30/89 Hole Completed: Time: 1330 Date: 06/30/89 Driller: Butch Drilling Company: CNI

Drill Method: Auger Drilling Fluids Used: None Pilot Hole Diameter: 9" Reamed Hole Diameter: N/A

Total Depth Drilled: 22.5' Total Depth Reamed: N/A Total Depth Cased Below G.S.: 18.5' Diameter and Type of Casing: 2" Flush Threaded PVC

Weight or Gage of Casing: Sch.40 Interval Perforated or Screened Below G.S.: 13.5' to 18.5' Target Aquifer: Alluvium Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	X	
Well Test Pumped?		X
Water Samples Taken?	X	
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened
- ☐ No casing in hole
- ☐ Open bottom
- ☐ Slotted with Mill's Knife
- ☐ Slotted with a torch
- ☐ Screened by pulling casing
- ☐ Field saw cut Hacksaw
- ☐ Mechanical slots _____ (size)
- ☒ Other (specify) .02" Factory

Static Water Level: 12.4' Date/Time Measured: 8/24/89

Measuring Point Description/Elevation: Top of steel/5445.26' MP Height Above (+/-) or Below G.S.: + 1.6'

Well Annulus Completion Description: 10-20 Colorado Silica sand 20.0-11.0'; 1/4" Bentonite pellets 9.5-11'; pure gold grout 1-9.5'; 1/4" Bentonite pellets 1-2.0'

Remarks: Concrete grout steel well protector at surface

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	19.0	Dark brown to black silty sand; dry; sand is coarse, rounded, occasional black fragments, fill material to ~10'; occasional scattered gravel, ~1" diameter; sub-angular; water at ~10', no noticeable change in lithology. Heaving sand at ~16.0'.
19.0	22.5	Silty sand; dark brown; some clay; much tighter than above. Hole stays open at 19.0'+.

PA

tte

093 3N 8W 24 ~~[illegible]~~

DAD

Silver Bow

RECEIVED
JUN 04 1990
MT. DEPT. of NATURAL RESOURCES & CONSERVATION

072055

WELL LOG REPORT

1. WELL OWNER
Name KOA CAMPGROUNG

2. CURRENT MAILING ADDRESS
1601 Kaw Ave
Butte MT 59701

3. WELL LOCATION same
County Silver Bow
Township 3 N Range 8 W
NE 1/4 SE 1/4 SECTION 24
Lot__________Block__________________
Subdivision____________________________
Tract Number___________________________

4. PROPOSED USE Domestic X
Irrigation ___________Stock___________
Other: ____________________________

5. DRILLING METHOD X Cable
Rotary ____Air ____FWD ____Reverse
______Jetted_____Other:________________

6. WELL LOG

From	To	Formation
0	2	Top Soil
2	7	Sand
7	21	Swampy Area
21	29	Sandy Clay
29	34	Clay
34	40	Gravel & Water

Visited by MSE
Spring 1991

PA

No: 50448

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	42

COMPLETIONS
perforations_________screen_________

Kind	From feet	To feet
Torch	34	40

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air ____Pump ____Bailer X
B. Static Water Level before: 8 FT
If flowing closed in pressure
______PSI ____GPM
Controlled by:
C. Depth of Pump for Test bailer FT
D. Pumping Rate & Discharge 40 GPM
E. Maximum Drawdown for test 25 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 1 min
G. Recovery Water Level 8 FT
Time after pumping recovery water data was taken 10 min

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED April 7 1990

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: April 27, 1990

O'Keefe Drilling Company
P.O. Box 3810 - 2000 Four Mile Road
Butte, MT. 59702

Signature ________________ 29 License No.
Lee Lock

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M: 50448

VISITED: 11/9/79

093 03N 08W 24DBCB SILVER BOW

GW 2

Approved Stock Form—State Publishing Co., Helena, Montana—42329

File No.

Montana Ave. Interchange 093 T. 3 N R. 8 W - 24

County Silver Bow DBC

TRIPLICATE

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER
OFFICE OF STATE ENGINEER

058162

1

Notice of Completion of Groundwater Appropriation by Means of Well

DEVELOPED AFTER JANUARY 1, 1962

(Under Chapter 237, Montana Session Laws, 1961)

LOG

Top of Ground

(Elev. above sea level 3451.00+)

Med. dense-Brown silty decomposed granite sand.

12.5'
Med. dense brown decomposed granite sand with water.

51.8'
Bottom hole in same material.

GEO: 110 ALVM

Show exact depth of bottom.

Owner Montana Highway Commission Address Helena, Montana

Driller Montana Highway Comm. Address Helena, Montana

Date of Notice of appropriation of groundwater June 4, 1971 ~~May 1[illegible], 1971~~

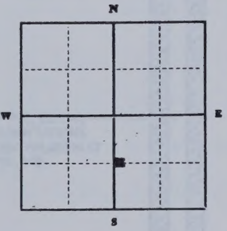
Date well started May 6, 1971 Date completed June 4, 1971 ~~May 10, 1971~~

Type of well Driven Equipment used Churn Drill
(Dug, Driven, bored or drilled) (Churn drill, rotary or other)

Water use: Domestic ☐ Municipal ☐ Stock ☐ Irrigation ☒
Industrial ☐ Drainage ☐ Other ☐

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which the water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS		
				Kind Size	From (Feet)	To (Feet)
6" ID	Steel 19.88 lb. per foot.	1.5' Above ground Line	42.3'	Used Johnson 6" well screen 30 slot from 42.3' to 51.8'		



[illegible] ¼ Sec. [illegible] T. [illegible] R. [illegible]

Indicate location of well and place of use, if possible. Each small square represents 40 acres.

Static Water Level for non-flowing well 11.0' feet.

Shut-in Pressure for Flowing Well

Pumping Water Level 17.0' feet at 37 gal. per minute.

Discharge in gal. per min. of flowing well

How Tested 3" pump

Length of Test 12 hours

Remarks: (Gravel packing, cementing, packers, type of shutoff)

(Continue on reverse side)

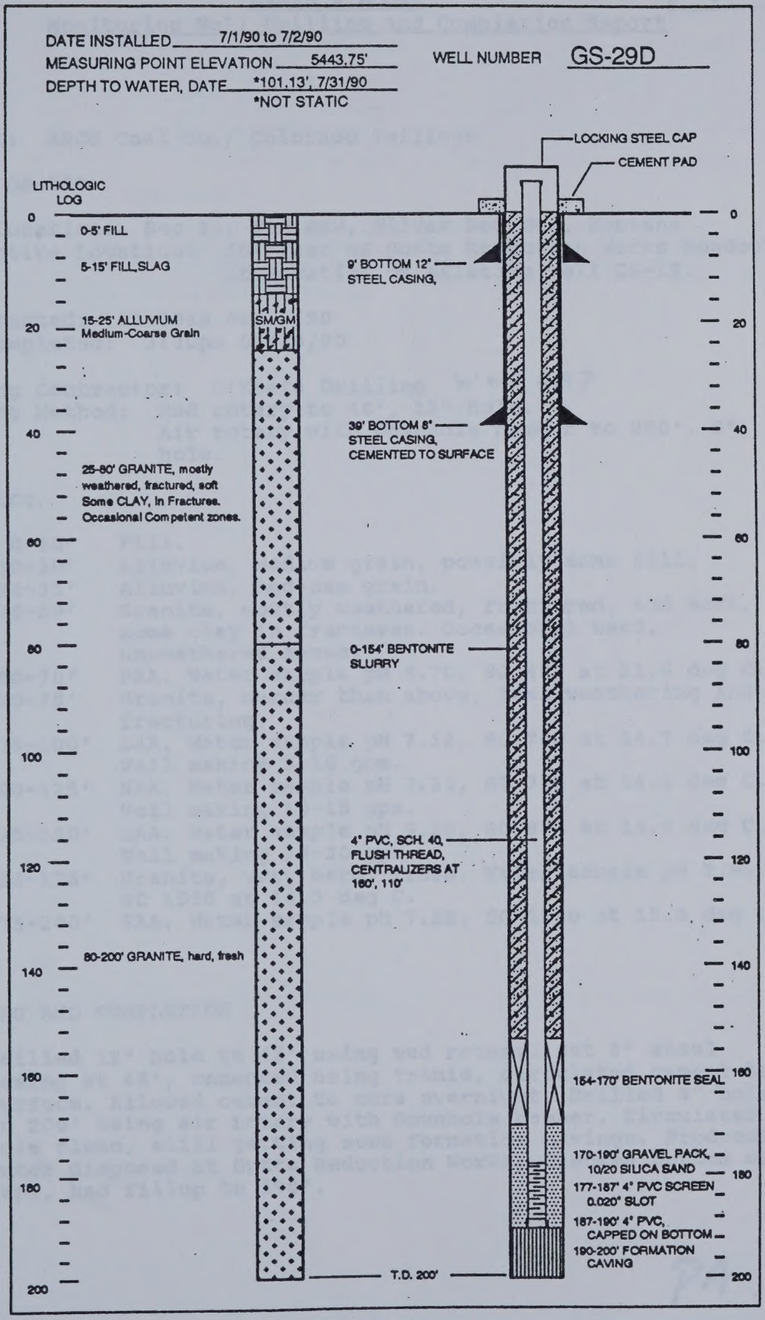
USE—If used for irrigation, industrial, drainage or other. Explain, state number of acres and location or other data (i.e.: Lot, Block and Addition).

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located, tissue copy to be retained by driller.

Please answer all questions. If not applicable, so state, otherwise the form will be returned.

[illegible]
Driller's License Number

Vincent R Kiely
Driller's Signature



DATE INSTALLED 7/1/90 to 7/2/90

MEASURING POINT ELEVATION 5443.75'

DEPTH TO WATER, DATE *101.13', 7/31/90

*NOT STATIC

WELL NUMBER GS-29D

LITHOLOGIC LOG
0
20
40
60
80
100
120
140
160
180
200
0-5' FILL
5-15' FILL,SLAG
15-25' ALLUVIUM Medium-Coarse Grain
SM/GM
25-80' GRANITE, mostly weathered, fractured, soft Some CLAY, in Fractures. Occasional Competent zones.
80-200' GRANITE, hard, fresh
LOCKING STEEL CAP
CEMENT PAD
9' BOTTOM 12" STEEL CASING,
39' BOTTOM 8" STEEL CASING, CEMENTED TO SURFACE
0-154' BENTONITE SLURRY
4" PVC, SCH. 40, FLUSH THREAD, CENTRALIZERS AT 160', 110'
154-170' BENTONITE SEAL
170-190' GRAVEL PACK, 10/20 SILICA SAND
177-187' 4" PVC SCREEN 0.020" SLOT
187-190' 4" PVC, CAPPED ON BOTTOM
190-200' FORMATION CAVING
T.D. 200'
0
20
40
60
80
100
120
140
160
180
200

3N08W24

SILVER BOW

086417

DAMES & MOORE
Monitoring Well Drilling and Completion Report

Project: ARCO Coal Co./ Colorado Tailings

Well: GS-19D

Legal Location: Sec 24, T3N,R8W, Silver Bow Co., Montana
Descriptive Location: 50' East of Butte Reduction Works Roadcut. At location of existing well GS-19.

Well Started: 12:00am 06/28/90
Well Completed: 3:30pm 06/29/90

Drilling Contractor: O'Keefe Drilling WWC 287
Drilling Method: Mud rotary to 46', 12" hole. Air rotary with downhole hammer to 200', 8" hole.

LITHOLOGY

0-10'	Fill.
10-20'	Alluvium, medium grain, possibly some fill.
20-35'	Alluvium, med-cse grain.
35-50'	Granite, mostly weathered, fractured, and soft, some clay in fractures. Occasional hard, unweathered zones.
50-70'	SAA. Water sample pH 6.70, SC 400 at 21.6 deg C.
70-75'	Granite, harder than above, less weathering and fracturing.
75-100'	SAA. Water sample pH 7.12, SC 700 at 14.7 deg C. Well making 5-10 gpm.
100-125'	SAA. Water sample pH 7.33, SC 720 at 14.1 deg C. Well making 10-15 gpm.
125-150'	SAA. Water sample pH 9.20, SC 900 at 14.4 deg C. Well making 15-30 gpm.
150-175'	Granite, very hard, fresh. Water sample pH 7.85, SC 1050 at 16.3 deg C.
175-200'	SAA. Water sample pH 7.58, SC 1150 at 15.8 deg C.

DRILLING AND COMPLETION

Drilled 12" hole to 46' using mud rotary. Set 8" steel casing at 46', cemented using tremie, circulated cement to surface. Allowed cement to cure overnight. Drilled 8" hole to 200' using air rotary with downhole hammer. Circulated hole clean, still getting some formation cavings. Produced water disposed at Butte Reduction Works. Checked bottom with tape, had fillup to 190'.

PA

M: 126151

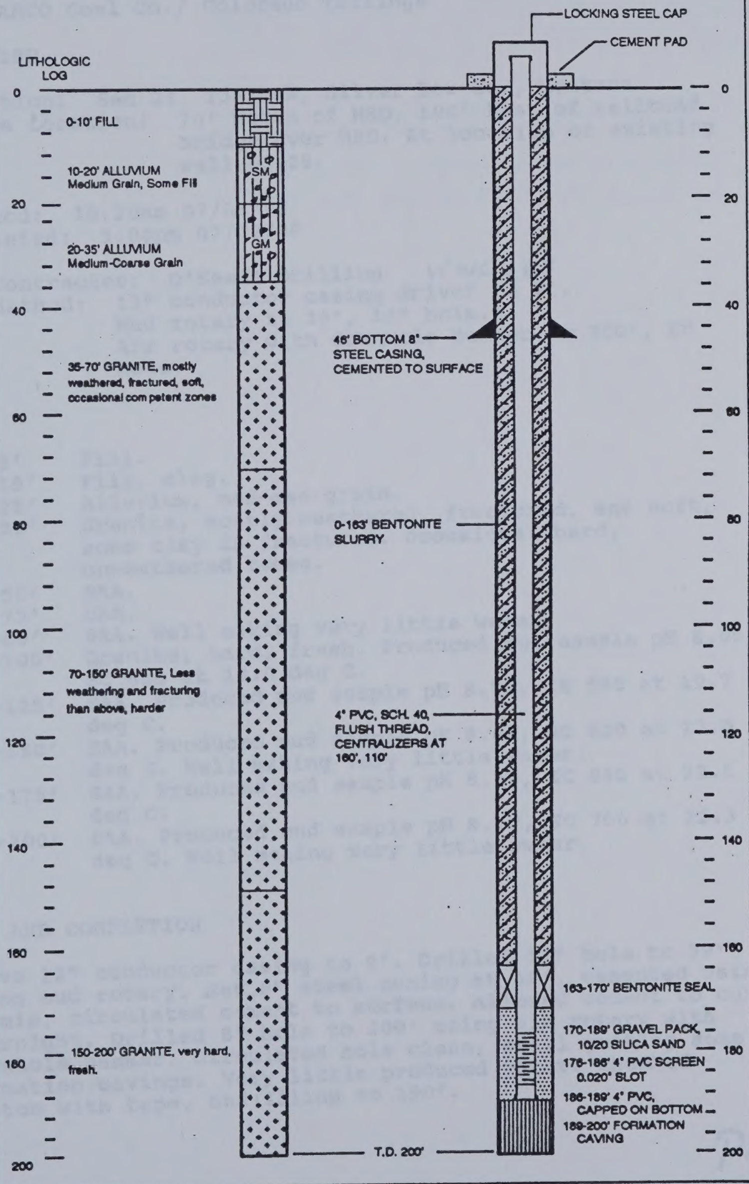
4" PVC Schedule 40 flush thread set at 189', centralizers at 160' and 110',threaded cap on bottom, slip cap at surface, 0.020" **slotted screen 176-186'**: Gravel pack (10/20 silica sand) 170-189'. Bentonite seal (Holeplug) 163-170'. Allowed seal to yield overnight. Pumped bentonite slurry (Pure Gold AquaGel) using tremie, circulated to surface. Checked water level inside PVC when pumping slurry, did not move. Installed locking steel cap, poured cement pad at surface.

DEVELOPMENT

07/18/90 Set submersible electric pump at approx. 180'. Began pumping 9:20am, pumped off 9:35am. Well stabilized at **1-3 gpm, water level** at pump, water clear. Last sample 10:55am, pH 7.17, SC 2850 at 15.1 deg C. Gathered sample for laboratory analysis.

DATE INSTALLED 6/28/90 to 6/29/90
MEASURING POINT ELEVATION 5446.51'
DEPTH TO WATER, DATE 14.50', 7/31/90

WELL NUMBER **GS-19D**



LOCKING STEEL CAP
CEMENT PAD
LITHOLOGIC LOG
0
20
40
60
80
100
120
140
160
180
200
0-10' FILL
10-20' ALLUVIUM Medium Grain, Some Fill
SM
GM
20-35' ALLUVIUM Medium-Coarse Grain
35-70' GRANITE, mostly weathered, fractured, soft, occasional competent zones
70-150' GRANITE, Less weathering and fracturing than above, harder
150-200' GRANITE, very hard, fresh.
46' BOTTOM 8" STEEL CASING, CEMENTED TO SURFACE
0-163' BENTONITE SLURRY
4" PVC, SCH. 40, FLUSH THREAD, CENTRALIZERS AT 160', 110'
163-170' BENTONITE SEAL
170-189' GRAVEL PACK, 10/20 SILICA SAND
176-186' 4" PVC SCREEN 0.020" SLOT
186-189' 4" PVC, CAPPED ON BOTTOM
189-200' FORMATION CAVING
T.D. 200'

3N08W24

Silver Bow

086418

DAMES & MOORE
Monitoring Well Drilling and Completion Report

Project: ARCO Coal Co./ Colorado Tailings

Well: GS-29D

Legal Location: Sec 24, T3N,R8W, Silver Bow Co., Montana
Descriptive Location: 70' North of MSD, 100' East of railroad bridge over MSD. At location of existing well GS-29.

Well Started: 10:30am 07/01/90
Well Completed: 3:00pm 07/02/90

Drilling Contractor: O'Keefe Drilling WWC287
Drilling Method: 12" conductor casing driver to 9'. Mud rotary to 39', 12" hole. Air rotary with downhole hammer to 200', 8" hole.

LITHOLOGY

0-5'	Fill.
5-15'	Fill, slag.
15-25'	Alluvium, med-cse grain.
25-39'	Granite, mostly weathered, fractured, and soft, some clay in fractures. Occasional hard, unweathered zones.
39-50'	SAA.
50-75'	SAA.
75-80'	SAA. Well making very little water.
80-100'	Granite, hard, fresh. Produced mud sample pH 8.05, SC 650 at 19.0 deg C.
100-125'	SAA. Produced mud sample pH 8.71, CS 500 at 19.7 deg C.
125-150'	SAA. Produced mud sample pH 8.44, SC 620 at 23.0 deg C. Well making very little water.
150-175'	SAA. Produced mud sample pH 8.66, SC 660 at 22.5 deg C.
175-200'	SAA. Produced mud sample pH 8.77, SC 700 at 22.3 deg C. Well making very little water.

DRILLING AND COMPLETION

Drove 12" conductor casing to 9'. Drilled 12" hole to 39' using mud rotary. Set 8" steel casing at 39', cemented using tremie, circulated cement to surface. Allowed cement to cure overnight. Drilled 8" hole to 200' using air rotary with downhole hammer. Circulated hole clean, still getting some formation cavings. Very little produced water. Checked bottom with tape, had fillup to 190'.

PA

M:126152

4" PVC Schedule 40 flush thread set at 190', centralizers at 160' and 110', threaded cap on bottom, slip cap at surface, 0.020" slotted screen 177-187'. Gravel pack (10/20 silica sand) 170-190'. Bentonite seal (Holeplug) 154-170'. Allowed seal to yield overnight. Pumped bentonite slurry (Pure Gold AquaGel) using tremie, circulated to surface. Checked water level inside PVC when pumping slurry, did not move. Installed locking steel cap, poured cement pad at surface.

DEVELOPMENT

07/05/90 Set submersible electric pump at approx. 180'. Well pumped off immediately, no fillup.

07/11/90 Water level 148.7' from top steel casing.

07/31/90 Water level 101.69' from top steel casing.

067841

TEST HOLE LOG

HYDROMETRICS

ARCO - Silverbow

Helena, M

State: Montana
County: Silverbow
Project: Creek
Hole Name or Number: BMW-8A
Legal Location: T 3N R 8W Sec. 24 Tract
Descriptive Location: North side of Reduction Works, 200 ft. sc of entrance gate
Recorded by: Bill Peery
Date Hole Started: 7/9/89
Date Hole Completed: 7/9/89
Driller: Mark
Drilling Company: WWC334 H & L
Drill Method: Rotary
Drilling Fluids Used: Air/water
Pilot Hole Diameter: 8+"
Reamed Hole Diameter: 8+"
Total Depth Drilled: 11.3 ft.
Total Depth Reamed: 11.3 ft.
Total Depth Cased Below G.S.: 11.3 ft.
Diameter and Type of Casing: 4" PVC
Weight or Gage of Casing: Sch 40
Interval Perforated or Screened Below G.S.: 5-11.3'
Target Aquifer: Alluvium
Packer Type and Depth Below G.S.: None

	YES	NO	
Well Developed?	X	air, 5 minutes, clear water	
Well Test Pumped?			1 gpm
Water Samples Taken?			
Material Samples Taken?	X		
E - Logs?			

Method Perforated or Screened:
☐ No casing in hole.
☐ Open bottom only.
☐ Slotted with Mill's Knife.
☐ Slotted with a torch.
☐ Screened by pulling casing.
☐ Saw cut
☒ Other (specify) .030 slot 4" P scree

Static Water Level: 7.4 feet Date: 7/9/89
Measuring Point Description/Elevation: Top of PVC riser
MP Height Above (±) or Below G.S.: + 1.0 ft.
Well Annulus Completion Description: Sand 2.8 to 11.3, bentonite to surface.
Remarks:

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	3	SAND, silty, grvelly, fill material. Dry.
3	6	SAND, silty, gravelly, Split spoon sample, primarily fine sand grading to medium sand, bedding easily visible due to color variations, fine grained texture with occasional small pebbles. Slightly moist.
6	11	SAND, silty - Medium to coarse sand, 5 to 10% silt, occasional small gravels, moist at 7 feet.
11	11.3	COBBLES AND GRAVEL, Not able to drive split spoon beyond 8 feet; hole collapsing at 11 feet. Drilling became harder, larger gravel in returns. Gravels and cobbles appear to be Missoula Gulch alluvial deposits (see log for BMW-8AB).

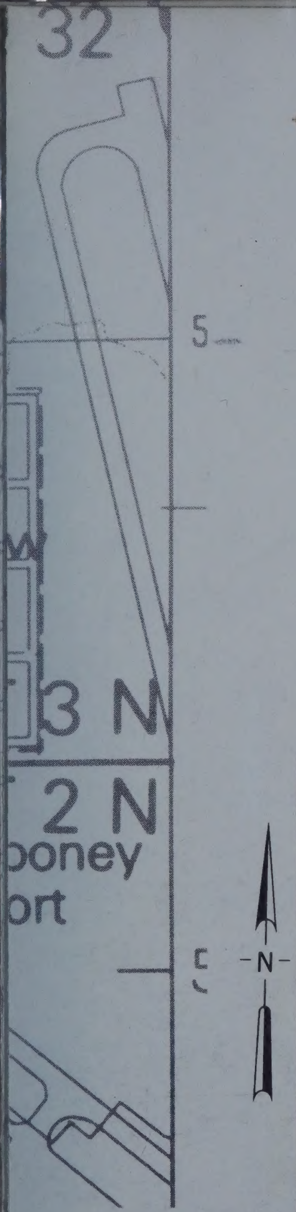
WELL COMPLETION:

6.3 feet of 0.030 slot 4" PVC from 5 to 11.3 feet.
4" PVC riser to surface.

Sand pack #16 sand from 2.8 to 11.3 feet (4 bags).
Granular bentonite to surface (1 bag).
PVC connections made with stainless steel screws.
Bentonite slurry to surface.

PA

M: 50437

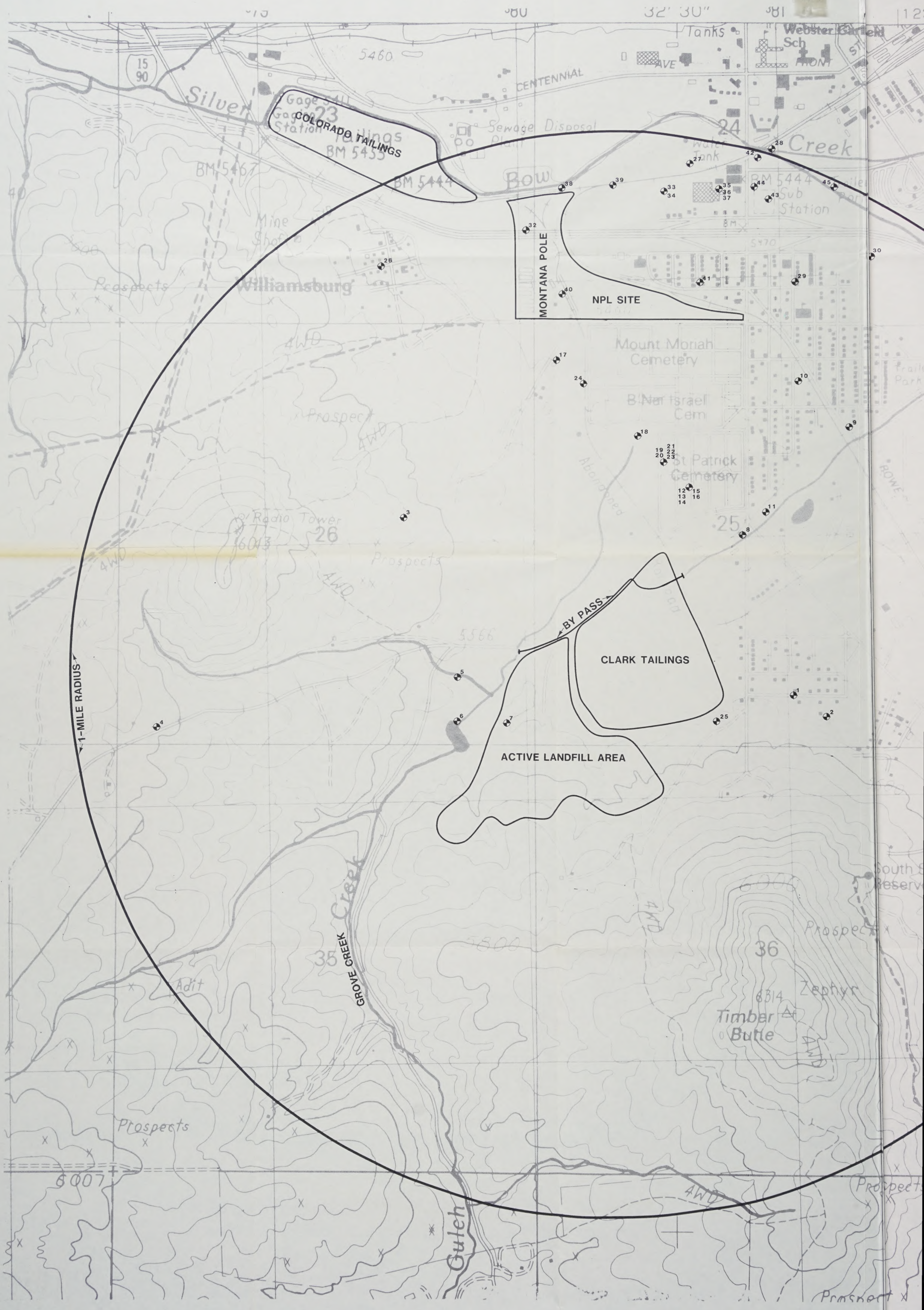


REV	ITEM	DESCRIPTION	DATE	DRAWN	CHECKED	APPV'D

Special Resource Management, Inc.
Specialists in Waste and Resource Management Technology

Figure 1
WELL LOCATION MAP

DRAWN BY	DATE
DESIGNED BY	BASE DWG.
CHECKED BY DATE	BASE DWG.
SCALE 1" : 500'	INDEX No.
	DRAWNING NUMBER REVISION


COLORADO TAILINGS
MONTANA POLE
NPL SITE
CLARK TAILINGS
ACTIVE LANDFILL AREA
BY PASS
1-MILE RADIUS
GROVE CREEK
1
2
3
4
5
6
7
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25
26
27
28
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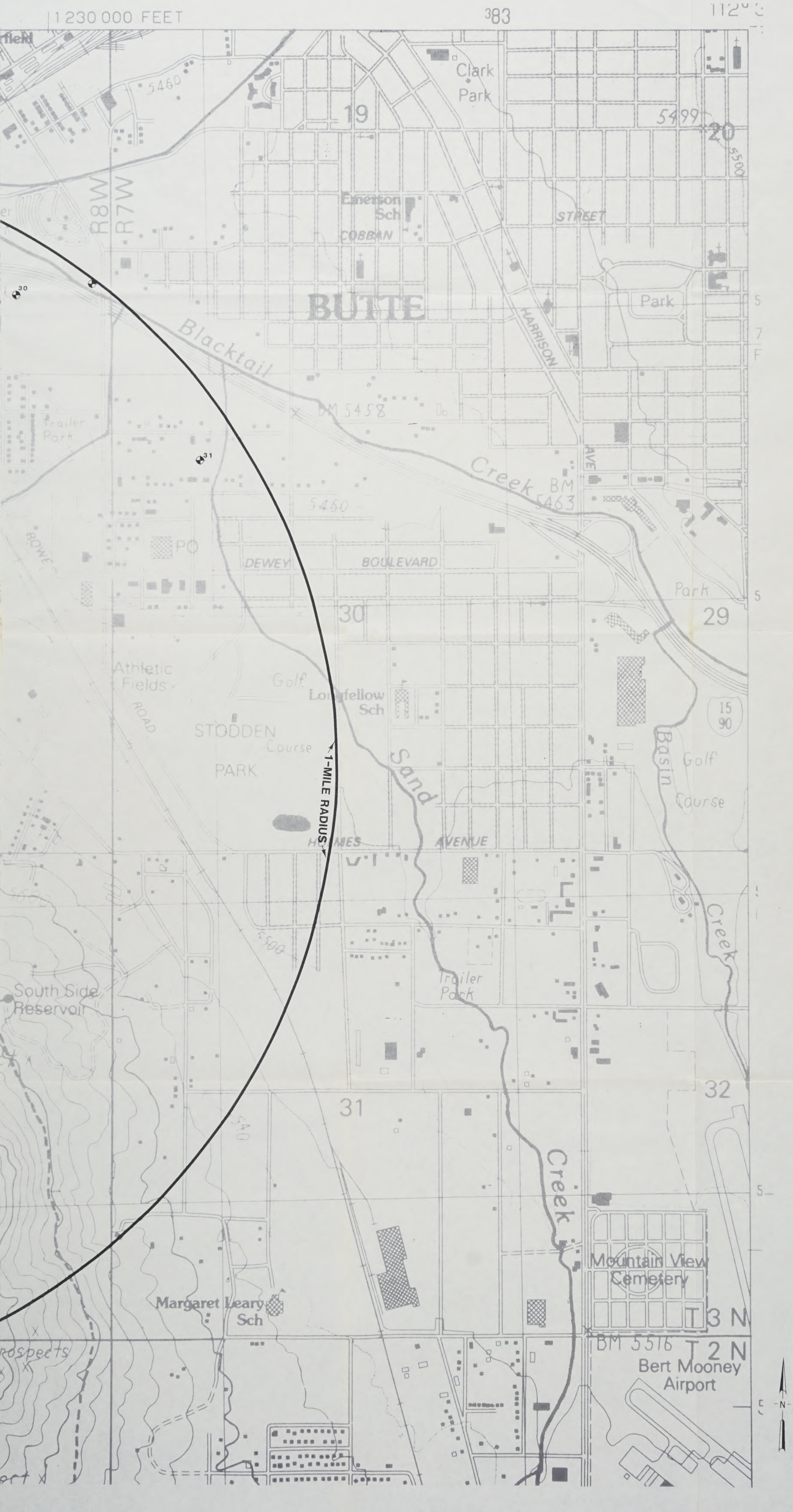
32
33
34
35
36
37
38
39
40
41
42
43
44
45
Silver Bow Creek
Tailings
Gage Station
BM 5433
BM 5444
BM 5467
Sewage Disposal Plant
CENTENNIAL AVE
Water Tank
Sub Station
Webster Garfield Sch
Williamsburg
Mine Shaft
Prospects
Prospect
Mount Moriah Cemetery
B'Nai Israel Cem
St Patrick Cemetery
Abandoned
Radio Tower
6013
5566
5800
6007
4WD
Adit
Grove Creek
Gulch
Timber Butte
6314
Zephyr
South Reservoir
23
24
25
26
35
36
15
90
5460
5470
32' 30"



1 230 000 FEET
383
112°
rfield
5460
Clark
Park
19
5499
20
5500
R8W
R7W
Emerson
Sch
STREET
COBBAN
30
BUTTE
Blacktail
Park
HARRISON
BM 5458
Trailer
Park
31
AVE
Creek
BM
5463
5460
ROWE
PO
DEWEY
BOULEVARD
Park
30
29
Athletic
Fields
Golf
Longfellow
Sch
15
90
ROAD
STODDEN
Course
1-MILE RADIUS
Basin
Golf
PARK
Sand
Course
HOLMES
AVENUE
Creek
5500
South Side
Reservoir
Trailer
Park
32
31
5540
Creek
Mountain View
Cemetery
Margaret Leary
Sch
T 3 N
BM 5516
T 2 N
Prospects
Bert Mooney
Airport
N

REV	ITEM	DESCRIPTION	DATE	DRAWN	CHECKED	APPV'D

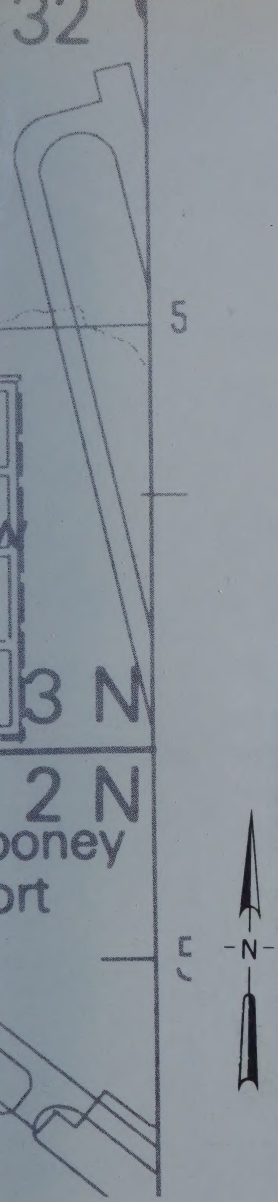
Special Resource Management, Inc

Specialists in Waste and Resource Management Technology

Figure 1

WELL LOCATION MAP

DRAWN BY	DATE
DESIGNED BY	BASE DWG.
CHECKED BY DATE	BASE DWG.
SCALE 1" : 500'	INDEX No.
	DRAWNING NUMBER REVISION



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Management, Inc.
Specialists in Waste and Resource Management Technology

Figure 2

SITE LOCATION MAP

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BASE DWG.
SCALE **1" : 500'**
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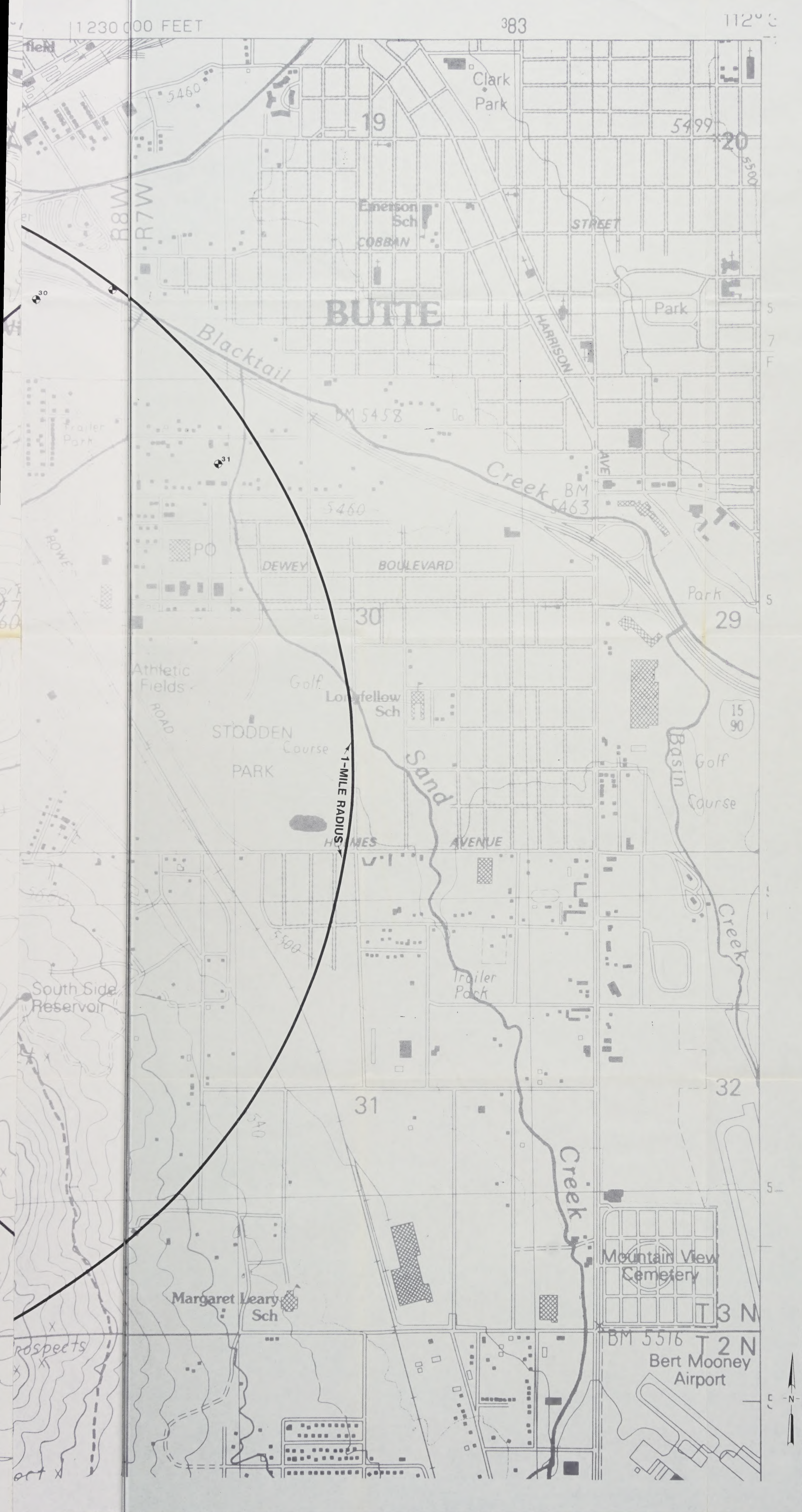
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BUTTE
Park
HARRISON
Blacktail
BM 5458
Trailer
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PO
DEWEY
BOULEVARD
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Athletic
Fields
Golf
Longfellow
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ROAD
STODDEN
Course
PARK
1-MILE RADIUS
Sand
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Basin
Golf
Course
HOLMES
AVENUE
5500
Creek
South Side
Reservoir
Trailer
Park
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Cemetery
Margaret Leary
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BM 5516
T 2 N
Bert Mooney
Airport
Prospects
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REV	ITEM	DESCRIPTION	DATE	DRAWN	CHECKED	APPV'D

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Figure 1

WELL LOCATION MAP

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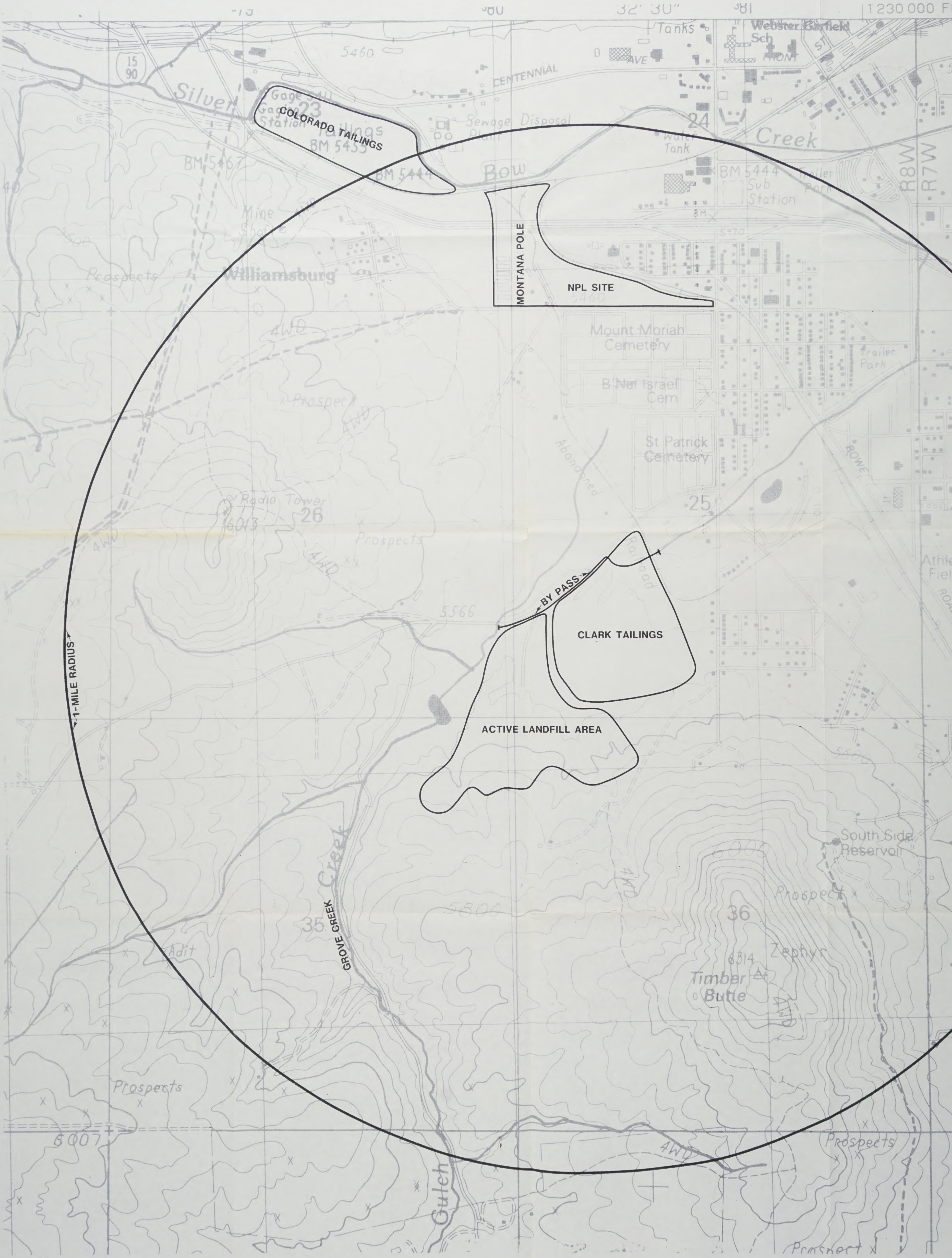
COLORADO TAILINGS
MONTANA POLE
NPL SITE
BY PASS
CLARK TAILINGS
ACTIVE LANDFILL AREA
1-MILE RADIUS
GROVE CREEK
Silver Bow Creek
Williamsburg
Mount Moriah Cemetery
B'Nai Israel Cem
St Patrick Cemetery
Radio Tower
Timber Butte
Zephyr
South Side Reservoir
Webster Garfield Sch
Sewage Disposal Plant
Water Tank
Sub Station
Trailer Park
Mine Shaft
Prospects
Adit
Gulch
Abandoned Railroad
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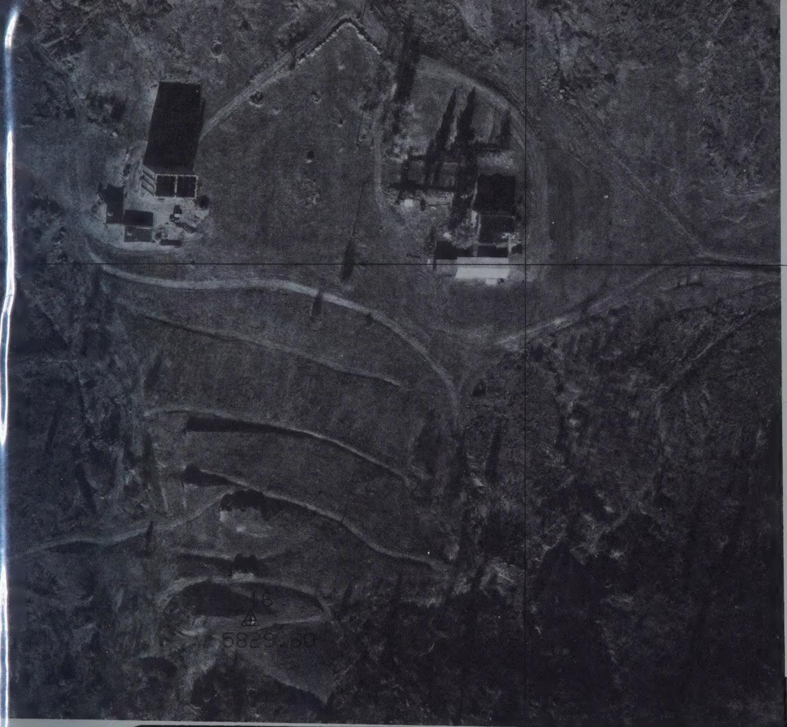

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Figure 3
DETAILED SITE MAP

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SCALE	INDEX No.	
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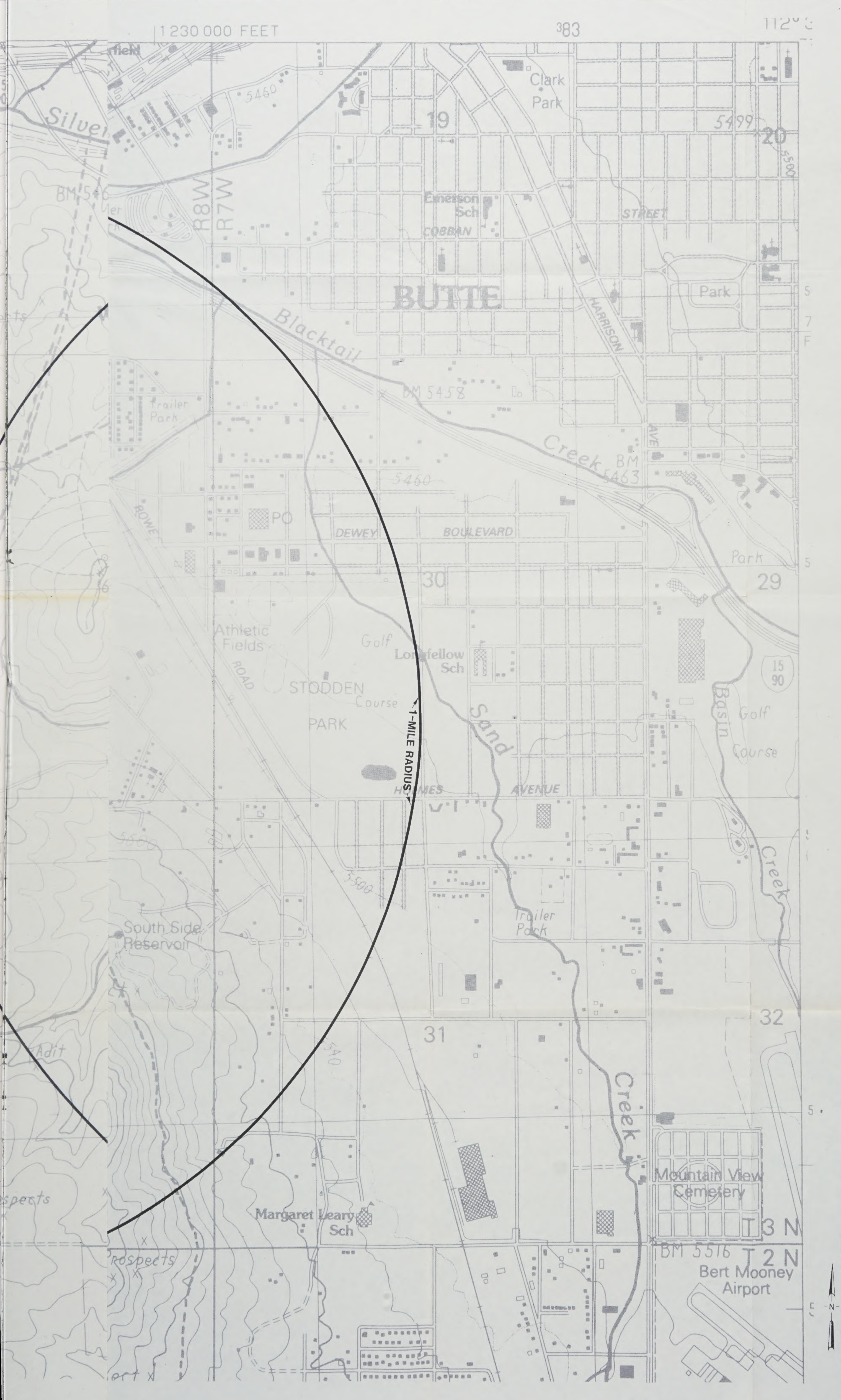
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R7W
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Clark Park
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Emerson Sch
COBBAN
STREET
BUTTE
Park
HARRISON
Blacktail
Creek
BM 5458
Trailer Park
BM 5463
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ROWE
DEWEY
BOULEVARD
Park
30
29
Athletic Fields
ROAD
Golf
Longfellow Sch
STODDEN
Course
PARK
15
90
Basin
Golf
Course
Sand
1-MILE RADIUS
HOLMES
AVENUE
Creek
5500
Trailer Park
South Side Reservoir
31
32
Adit
5540
Creek
Mountain View Cemetery
Prospects
Margaret Leary Sch
T 3 N
T 2 N
BM 5516
Bert Mooney Airport
N

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Figure 2
SITE LOCATION MAP

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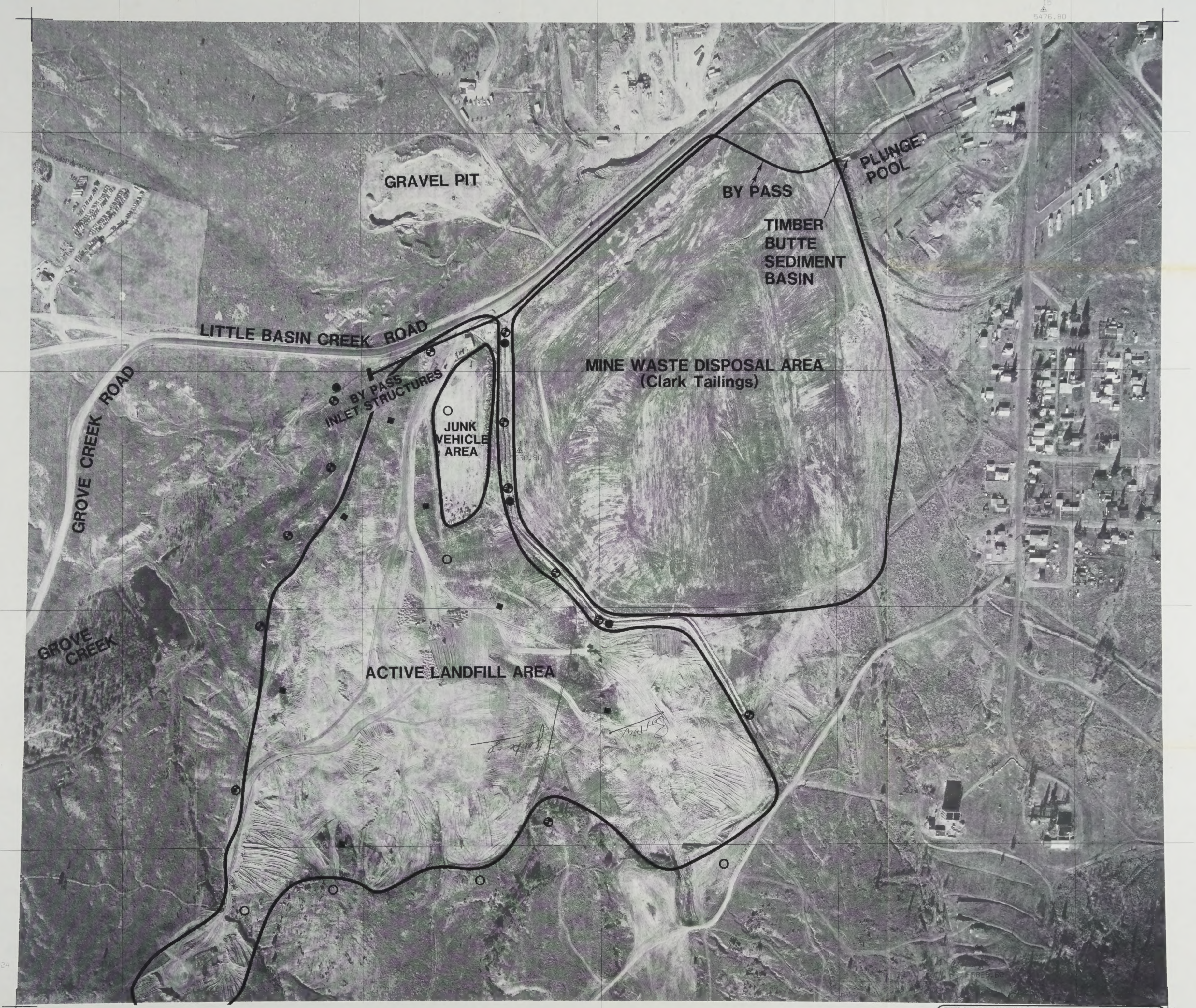
SCALE 1" : 500'	INDEX No.
	DRAWNING NUMBER REVISION


15
5476.80
GRAVEL PIT
BY PASS
PLUNGE POOL
TIMBER BUTTE SEDIMENT BASIN
LITTLE BASIN CREEK ROAD
GROVE CREEK ROAD
BY PASS INLET STRUCTURES
JUNK VEHICLE AREA
MINE WASTE DISPOSAL AREA
(Clark Tailings)
GROVE CREEK
ACTIVE LANDFILL AREA
18
5656.24
5829.60

LEGEND

- ● DEEP MONITORING WELLS (screened above bedrock)
- ⊗ MONITORING WELLS
- ○ BORINGS
- ■ BACK HOE PITS

SCALE 1" = 200'

200 0 200 400 600 800

GRAPHIC SCALE IN FEET

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Figure 3
DETAILED SITE MAP

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PIONEER
TECHNICAL SERVICES, INC.

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County Silver Bow
Facility & # 20
Closure
Finan Assur
GW Corr Meas
[✓ GW Monitoring]
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run-on

ORIGINAL

Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP)

Butte-Silver Bow

RECEIVED
JUN 1 5 2015
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Prepared for:
Butte-Silver Bow
Department of Public Works
126 W. Granite, Butte, Montana 59701

Prepared by:
Pioneer Technical Services, Inc.
P. O. Box 3445 Butte, Montana 59702

June 2015

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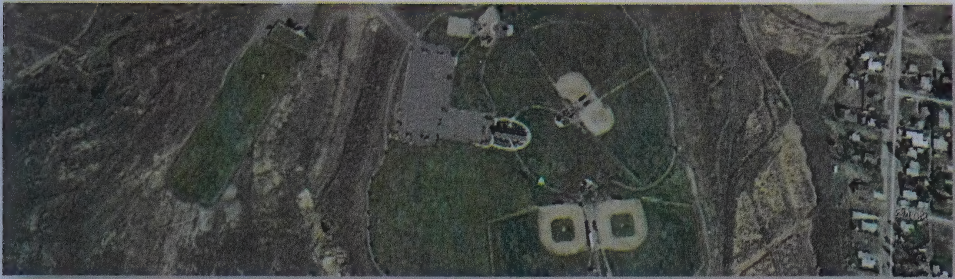
TECHNICAL SERVICES, INC.

RESTORING OUR ENVIRONMENT • DESIGNING OUR FUTURE

ORIGINAL

Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP)

Butte-Silver Bow



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P. O. Box 3445 Butte, Montana 59702

June 2015

PIONEER
TECHNICAL SERVICES, INC.

June 12, 2015

Mr. John Collins
Permitting and Compliance Division
Solid Waste Program
P.O. Box 200901
Helena, Montana 59620-0901

RE: Closed Butte-Silver Bow County Landfill – License #20
Updated Sampling and Analysis Plan

Dear John,

Included with this letter is the updated Sampling and Analysis Plan for the Old Landfill/Clark Tailing site located in Butte, Montana, prepared for Butte-Silver Bow County by Pioneer Technical Service, Inc. for your review/comment.

If you have questions after reviewing this document please contact myself at 406-490-7678 or Mitch Mihailovich at 406-490-7678 or 406-497-8045 respectively.

Sincerely,

Brad Hall

Brad Hollamon
Senior Technician

cc: Dave Schultz, Butte- Silver Bow County Public Works Department
J.D. Emmert Pioneer
M. Mihailovich

HEADQUARTERS: PO BOX 3445 • BUTTE, MT 59702 | PH: 406.782.5177 • FX: 406.782.5866 | WWW.PIONEER -TECHNICAL.COM
ANACONDA • BILLINGS • BOZEMAN • HELENA • MISSOULA • EVANSTON, WY • KELLOGG, ID

Butte- Silver Bow
Old Landfill Facility

PIONEER
TECHNICAL SERVICES, INC.

June 12, 2015

Groundwater Sampling and Analysis Plan

case LOGIC

Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP)

Prepared for:
Butte-Silver Bow
Department of Public Works
126 W. Granite, Butte, Montana 59701

Prepared by:
Pioneer Technical Services, Inc.
P. O. Box 3445
Butte, Montana 59702

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Appendix B Pioneer Groundwater Monitoring, Standard Operating Procedures
Appendix C Health and Safety Plan for Old BSB Municipal Landfill Site/Clark Tailings Facility
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Appendix E DEQ Letter Correspondence
Appendix F Field Parameter Form

1 INTRODUCTION

This Sampling and Analysis Plan (SAP) presents the sampling procedures, laboratory analytical methods, and quality assurance/quality control (QA/QC) procedures applicable to routine groundwater monitoring activities at the Old Butte-Silver Bow (BSB) Municipal Landfill/Clark Tailings Facility- License #20 (Old Landfill). The procedures identified in this SAP are intended to meet the regulatory requirements outlined in the Montana Solid Waste Management Regulations (Administrative Rules of Montana [ARM] 17.50.1305) (ARM, 2015a).

1.1 Purpose and Objectives

The objectives of the groundwater monitoring activities at the Old Landfill are as follows:

1. Document and monitor background groundwater quality.
2. Document approved methods to sample and analyze groundwater, which provides data that are complete, precise, accurate, and defensible.
3. Document the procedures to continue assessment monitoring as outlined in ARM 17.50. 1307 (ARM, 2015c).

2 BACKGROUND

2.1 Location

The Old Landfill is located approximately 1 mile southwest of the city of Butte and covers approximately 130 acres (Figure 1). The site is located in portions of sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County. The Old Landfill is accessed by traveling west to Butte, Montana, on U.S. Interstate 90 (I-90), exiting at exit ramp 126, turning south on Montana Street, traveling approximately 0.65 miles on Montana Street, turning southwest onto Beef Trail Road, traveling approximately 0.5 miles, and turning east into the Copper Mountain Sports and Recreation Complex, which overlies the Old Landfill. The Copper Mountain Sports and Recreation Complex is composed of baseball diamonds, a walking trail, football/soccer fields, a children's playground, sand volleyball courts, and a driving range. An American Legion youth facility baseball field with lights and stands to seat 300 people is presently being constructed and is expected to be in use by 2016.

2.2 Site History

The Old Landfill opened in 1968 and accepted municipal solid waste from Butte and its vicinity. In 1978, the Montana Department of Environmental Quality (DEQ) issued an operating license for the Old Landfill (License #20)—a permit was not required previously. The Old Landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new BSB Sanitary Landfill). It is estimated that approximately 600,000 tons of refuse had

been disposed of at the site (Pioneer, 1997). During November 1990, the DEQ conducted a Preliminary Assessment (PA) of the Landfill in accordance with the National Contingency Plan (NCP). The site did not score high enough to be included as a Superfund site. In July 1992, BSB was notified by DEQ that a Groundwater Monitoring Plan and a Groundwater SAP were required at the Landfill. Wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Well locations are shown on Figure 2. Ensuing groundwater sampling events detected constituents listed in ARM 17.50.1306 (Appendix I to 40 CRF Part 258 [July 1, 2008] (ARM, 2015b) (Table 1) that exceeded specified action levels. Accordingly, assessment monitoring as detailed in ARM 17.50.1307 (ARM, 2015c) was conducted and subsequent samples were analyzed for constituents (Appendix II to 40 CFR Part 258 [July 1, 2008] (Table 2). Assessment monitoring results showed that groundwater protection standards (GWPS) were exceeded for certain volatile organic compounds (VOCs) and thallium. Groundwater monitoring has been conducted biannually since that time. Landfill capping and passive gas venting as a corrective measure was approved on March 21, 1997, and remedial construction began in 1997 and was completed in 1998.

The Clark Tailings consisted of a 60-acre impoundment with approximately 1,000,000 cubic yards (cy) of mill tailings (Hydrometrics, 1983) immediately adjacent to and partially mixed with the Landfill. The mixed nature of the wastes necessitated that a combined Superfund and Resource Conservation and Recovery Act (RCRA) response action be performed under RCRA jurisdiction.

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During its years of operation, the mill served primarily as a zinc and copper concentrator. The Clark Tailings were reclaimed in the mid-1980s by the Anaconda Minerals Company as part of the "Clark Tailings Erosion Control Project;" however, vegetation recovery was sparse in many areas and it was determined that additional reclamation was necessary. During reclamation of the Colorado Tailings in the Lower Area One Operable Unit in the Butte-Silver Bow Superfund Site, approximately 800,000 cy of tailings were placed in a repository constructed at the Clark Tailings.

The final RCRA repository cover for the Old Landfill was designed in 1997 and constructed in 1997 and 1998. The Copper Mountain Recreational Complex was included as part of the final design and today the reclaimed area has several irrigated baseball and football fields, a walking trail, a children's playground, and sand volleyball courts.

Since that time concentrations of constituents in Table 2 have been reported at or below background values for two consecutive sampling events. The owner, BSB, submitted requests in March 2013 and April 2015 for removal of constituents from the assessment monitoring requirements and has received DEQ department approval (Appendix E) to sample semi-annually for the constituents listed in Table 3.

Analytical data from all past monitoring activities are available in hard-copy form at the BSB Public Works office located at 126 W. Granite Street in Butte, Montana. Data records (in

electronic and hard-copy format) are also available at the office of Pioneer Technical Services, Inc. (Pioneer) located at 1101 S. Montana Street in Butte, Montana.

3 SAMPLING AND ANALYSIS

3.1 Groundwater Monitoring Scope

The scope of this SAP is limited to the sampling of six wells (shown on Figure 2): three groundwater monitoring wells currently located within the Old Landfill (BSB-A1, BSB-A5 and BSB-A6R), a monitoring well located on BSB land just west of the Old Landfill (MBMG-2), a monitoring well located on the northwest corner of the Old Landfill and in the right-of-way of Little Basin Creek Road (CLK-2), and a monitoring well located on private property east of the Old Landfill boundaries (CLK-1). Keys for the well locks are located at Pioneer's main office located at 1101 S. Montana St. in Butte, Montana, and also at Pioneer's Parrot office on Anaconda Road, also in Butte, Montana. Wells BSB-A1, BSB-A5, MBMG-2, BSB-A6R, and CLK-2, located on BSB land, are accessed between the hours of 8:00 a.m. and 10:00 p.m. (these are the hours that Copper Mountain Park is open to the public). Static water levels will be measured in each of these wells on a semi-annual basis, in approximately March and September, to document depth-to-groundwater and groundwater flow direction. Additionally, groundwater samples will be collected from the six wells on a semi-annual basis. These samples will be analyzed in compliance with the revised assessment monitoring requirements as detailed in the acceptance letters from DEQ dated May 2013 and April 2015 (Appendix E).

One monitoring well (MBMG-2) is located cross gradient from the facility and is considered the background well (to document background groundwater quality). The remaining five wells (BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2) are designated as "monitoring wells." BSB-A1, BSB-A5, BSB-A6R, CLK-1, and CLK-2 are also the designated Point of Compliance (POC) wells. Table 1 provides installation specifications (diameter, total depth, etc.) for each well, the order in which the wells are to be sampled, and also lists the sample number that is assigned to each well when monitoring activities are conducted.

3.2 Butte-Silver Bow Landfill Groundwater Monitoring Wells

Monitoring well MBMG-2 is located to the west of the Old Landfill (Figure 2). This well is located cross gradient from all reclamation activities that occurred at the Old Landfill and is considered the background well. Sampling activities at this well involve recording the static water level followed by purging using modified low flow techniques (see Appendix A) with a variable speed pump and Teflon tubing dedicated to the well. A minimum of 3 casing volumes purged and 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, specific conductance [SC], dissolved oxygen [DO] and oxidation-reduction potential [eH]) are recorded using the Field Parameter Form (see Appendix F) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%. Samples from MBMG-2 are

submitted for the following laboratory analyses: VOCs, dissolved metals, chloride, chemical oxygen demand (COD), conductivity, cyanide, nitrate/nitrite, pH, and sulfate. During the March sampling event, a sample is also analyzed for sulfide (Table 3).

Monitoring well BSB-A1 (POC Well) is located near the northwest corner of the Old Landfill boundaries and downgradient of the historic disposal area (Figure 2). Sampling activities at this well involve recording the static water level followed by purging using modified low flow techniques (see Appendix A) with a variable speed pump and dedicated Teflon tubing. A minimum of 3 casing volumes purged and 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO and eH) are recorded on the Field Parameter Form (see Appendix F) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%. Samples from BSB-A1 are submitted for the following laboratory analyses: VOCs, chloride, COD, conductivity, cyanide, nitrate/nitrite, pH, and sulfate. During the March sampling event, a sample is also analyzed for sulfide (Table 3).

Monitoring well BSB-A5 (POC Well) is located on the north edge of the former Clark Tailings (Figure 2). It is located cross gradient from the historic tailings impoundment and downgradient of the former landfill disposal areas. Sampling activities at this well involve recording the static water level followed by purging with a dedicated double check ball Teflon bailer. A minimum of three casing volumes are purged prior to sampling. Due to poor recharge, the well is often purged dry during the initial purging. The well is allowed to sit and then sampled over the next eight hours as recharge occurs. This well is often dry during the March sampling event. Field parameters (temperature, pH, SC, DO, and eH) are recorded once prior to sample collection. Samples from BSB-A5 are submitted for the following laboratory analyses: VOCs, chloride, COD, conductivity, cyanide, nitrate/nitrite, pH, and sulfate. If water is present during the March sampling event, a sample is collected for sulfide analysis (Table 2). When sufficient water for all analysis cannot be collected, the sample containers will be collected in the following order: VOCs, raw (chloride, sulfate, COD, pH, and SC), nitrate/nitrite, cyanide, sulfide, and field parameters.

Monitoring well BSB-A6R is located near the center of the Copper Mountain Sports and Recreation Facility (Figure 2). It was installed in 2001 to replace monitoring well BSB-A6, which was removed during reclamation. Sampling activities at this well involve recording the static water level followed by purging using modified low flow techniques (see Appendix A) with a variable speed pump and dedicated Teflon tubing. A minimum of 3 casing volumes purged and 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO, and eH) are recorded using the Field Parameter Form (see Appendix F) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from BSB-A6R are submitted for the following laboratory analyses: VOCs, chloride, COD, conductivity, cyanide, nitrate/nitrite, pH, and sulfate (Table 3). During the March sampling event, 1 sample is also analyzed for sulfide.

Monitoring well CLK-1 is located on the northeast side of the original Clark Tailings on private property (Figure 2). Sampling activities at this well involve recording the static water level followed by purging with a 12-volt submersible pump and Tygon tubing. A minimum of 3 casing volumes purged and 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. After the well is appropriately purged, the sample is collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO, and eH) are recorded using the Field Parameter Form (see Appendix F) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from CLK-1 are submitted for the following laboratory analyses: dissolved metals, chloride, conductivity, pH, and sulfate (Table 3).

Monitoring well CLK-2 is located on the north end of the original Clark Tailing complex and is downgradient of the Old Landfill (Figure 2). Sampling activities at this well involve recording the static water level followed by purging with a 12-volt submersible pump and Tygon tubing. A minimum of 3 casing volumes purged and 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Flow is restricted to approximately 0.25 gallons per minute during purging to prevent the well from going dry. Field parameters (temperature, pH, SC, DO, and eH) are recorded using the Field Parameter Form (see Appendix F) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from CLK-2 are submitted for the following laboratory analyses: dissolved metals, chloride, conductivity, pH, and sulfate (Table 3).

3.3 Groundwater Monitoring Procedures

During each semi-annual sampling event, depth-to-groundwater (static water level) is measured at the specified measuring point on each well casing using an electronic probe. This information is recorded in the field logbook. A dedicated, double-check valve Teflon bailer is used to purge and sample BSB-5. A decontaminated, variable speed 12-volt submersible pump and Teflon tubing dedicated to each well is used for modified low-flow (see Appendix A) purging and sampling of MBMG-2, BSB-1, and BSB-A6R. Because organic samples are not collected from CLK-1 and CLK-2, a decontaminated, variable speed 12-volt submersible pump and Tygon tubing is used to sample these wells. A minimum of 3 well casing volumes is purged before samples are collected. Samples are collected from each well only after one of the following purge conditions is met:

- The well is bailed or pumped dry and allowed to recover sufficiently so that an adequate volume of water for collecting samples can be removed;

- More than three well casing volumes have been purged; and

- Field parameters have stabilized. Stabilization is defined as 3 consecutive readings of temperature, pH, and SC within 10%.

Following well purging procedures, water quality samples are collected. Sample containers are filled directly from the pump or by pouring directly from the bailer into the appropriate sample containers. When a pump is used to collect the sample, the water flow is reduced to provide a steady, non-aerated flow while purging and filling the sample bottles. When a bailer is used to collect the sample, the bailer is inverted slightly to provide a steady, non-aerated flow while filling the bottles. Field parameters (SC, pH, DO, temperature, and eH) are collected during purging prior to sample collection and are recorded in the Field Parameter Form (Appendix F).

The samples are analyzed in compliance with the detection monitoring requirements listed in ARM 17.50.1306, Table 1 (ARM, 2015b). Table 3 contains a list of the following required analyses:

- Dissolved metals (see Table 3 for complete list)
- Cyanide
- Chloride
- Nitrate (as N)
- Sulfate
- COD
- pH
- SC
- VOCs, including Acrylonitrile (EPA Method 8260)

Samples for dissolved metals analyses are filtered by one of the following methods:

- If the sample is collected using a bailer, the water is transferred to a clean sample container and then pumped from the sample bottle through a new, disposable hi-volume filter capsule (0.45 microns [µm]), into a second sample container using a peristaltic pump and disposable tubing. After filtering, the sample is preserved using the appropriate preservative.

- If the sample is collected using a pump, a new, disposable hi-volume filter capsule (0.45 µm) is attached to the pump tubing (effluent), and the water is pumped through the filter directly into the sample container. After filtering, the sample is preserved using the appropriate preservative.

Following collection, all samples are preserved using the appropriate preservative for the intended analysis. The appropriate containers, preservatives, laboratories, and holding times for the analyses are listed in Table 3. All samples are stored with ice in coolers for transport to the office or to the laboratory. Samples are stored in coolers or are refrigerated from the time of

collection until delivery to the analytical laboratory. Strict chain of custody procedures (see Appendix B, Standard Operating Procedures [SOPs]) are adhered to at all times.

3.3.1 Sample Identification

Alpha-numeric sample identification codes are assigned to the groundwater samples collected from each well as indicated in Table 1. Sample identifiers are designated using the following logic:

- BSB - site code designating the site as the Old Landfill;
- GW- sample media code designating that the sample type is groundwater; and
- Location code designating the well (Table 2 lists which location code is associated with each well).

3.3.2 Sample Preservation and Handling

All samples are preserved immediately following sample collection. Table 3 lists sample holding times, preservation methods, and appropriate containers, etc. All samples are stored in coolers (with ice) at approximately 4 (plus or minus 2) degrees Celsius (°C) during transport. The samples are stored in coolers (on ice) or are refrigerated from the time of collection until delivery to the analytical laboratory. Samples for organic and inorganic analyses are shipped via Federal Express within 24 hours of sampling to Pace Analytical Laboratories located in Minneapolis, Minnesota. All samples are handled and transferred under strict chain of custody procedures. Custody seals are placed on shipped coolers to protect the integrity of the samples while in transit to the laboratory. The laboratory disposes of any sample portion not used for analysis, in accordance with their sample disposal policy.

3.3.3 Supplies and Equipment

The required supplies and equipment necessary to complete the monitoring procedures addressed in this SAP are listed in Table 4. The items are broken down into two main categories: groundwater monitoring equipment/supplies and health and safety supplies.

3.3.4 Instrument Calibration

All portable meters are calibrated daily in accordance with the manufacturer's instructions issued with the equipment and Pioneer's SOPs (Appendix B). Calibration results are recorded in the field logbook.

3.3.5 Documentation

All sampling activities and field data collection are recorded in a bound field logbook dedicated to groundwater monitoring activities at the Old Landfill. All applicable logbook entries are completed prior to proceeding to the next sampling site. The Field Team Leader is responsible for recording information including, but not necessarily limited to, the following: date and time of sample collection, weather conditions, field crew members, samples collected (including appropriate sample identifier), procedures used, field data collected using Field Parameters Form

(see Appendix F), and any deviations from this SAP. Chain of custody forms are completed in accordance with Pioneer's SOP (PTS-SOP-SA-04).

3.3.6 Decontamination Procedures

The Old Landfill is considered low risk for contaminant exposure to the field team members. However, a complete Health and Safety Plan has been developed for the site (see Appendix C) and all personnel are subject to decontamination procedures when leaving a contaminated area for their own protection (in accordance with SOPs in Appendix B). Personnel decontamination includes routine practices and emergency decontamination. All project personnel will take measures to prevent the spread of potentially hazardous materials to clean areas. All sampling equipment and personal protective materials generated on the site is containerized and disposed of properly. Purge water is disposed of on the ground adjacent to each well. Due to the reported levels of constituents in wells BSB-A6R and CLK-1, purge water from these wells will be containerized and disposed of according to federal, state, and local requirements.

All reusable equipment will be decontaminated after each use (in accordance with SOPs in Appendix B). Decontamination procedures are applicable to the electronic probes for the static water level indicator, pH meter, SC meter, DO meter, eH meter, and 12-volt pump. Visible contamination is wiped off with a paper towel and then the probes are thoroughly sprayed with de-ionized water and dried with paper towel. The 12-volt submersible pump is decontaminated by placing the pump into a container of tap water and pumping a minimum of 2 gallons of tap water thru the pump and then rinsing the pump with de-ionized water prior to reuse.

4 DEPARTMENT OF ENVIRONMENTAL QUALITY NOTIFICATION

A minimum of 14 days prior to each sampling event, written notification will be provided to the DEQ Solid Waste Regulatory Program. Letter, fax, or e-mail notification is acceptable. Contact information for the notification is as follows:

Solid Waste Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901
Fax: 406-444-1374

5 GROUNDWATER MONITORING SCHEDULE

Groundwater monitoring will occur semi-annually, during high and low groundwater conditions. Sampling events will generally occur six months apart in March and September, depending on weather and site access conditions. The monitoring work outlined under this SAP is expected to take two days to complete per each monitoring event.

6 LABORATORY AND FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

6.1 Field Generated Quality Assurance/Control Samples

Field QC protocols will be consistent with Pioneer SOPs and will include the following annually (at a minimum): one field duplicate and one field blank. The field duplicate is used to verify the reproducibility of the monitoring data. The field blank is used to verify the quality of the laboratory data and the cleanliness of the sample containers.

The field duplicate is generated in the field by collecting two samples from one groundwater sample location at the same time. The field duplicate is analyzed for dissolved metals, VOCs, chloride, conductivity, pH, and sulfate. The field blank is generated in the field by pouring purified water directly into appropriate sample containers. The field blank is analyzed for dissolved metals, chloride, conductivity, pH, sulfate, and VOCs.

7 LABORATORY GENERATED QUALITY ASSURANCE/CONTROL SAMPLES

Laboratory QA/QC samples are generated at a rate of 5% (1 per 20 analytical samples) or 1 per submitted batch; whichever is more frequent. Laboratory QA/QC samples include the preparation blank (PB), which is used to assess laboratory contamination and analytical bias near the limit of detection; and the laboratory control sample (LCS), which is used to determine accuracy of the preparatory steps and analysis. Additionally, laboratory duplicates or matrix spike duplicates are used to determine precision of the preparatory steps and analyses. Matrix spike samples consist of spiking the sample matrix with a known amount of analyte. The recovery of the analyte from the spiked sample matrix is used to assess the interferences present in the sample. These are the minimum QA samples the laboratory uses to monitor preparation and analysis. Other QA samples are run during instrumental analyses to monitor the accuracy and ongoing precision (drift) during the analytical run. Not all the QA samples are appropriate for every determinative method; however, as many of the QA sample types as possible are applied to each method. A typical summary of the Pace Analytical Laboratory QA Program is included in Appendix D.

8 ANALYTICAL METHODS

Groundwater samples collected from MBMG-2, BSB-A1, BSB-A5, and BSB-A6R are analyzed for VOCs, chloride, COD, conductivity, cyanide, nitrate/nitrite, pH, and sulfate. A sample for dissolved metals is also collected from MBMG-2. Also, the four previously mentioned wells are analyzed for sulfide during the March sampling event. Groundwater samples collected at CLK-1 and CLK-2 are analyzed for dissolved metals, chloride, conductivity, pH, and sulfate (Table 2). The specific methods that are applicable to each analysis are presented in Table 3.

9 DATA MANAGEMENT AND STATISTICAL ANALYSIS

Pioneer enters and stores all analytical data generated for groundwater monitoring at the Old Landfill into a Microsoft Excel spreadsheet that is maintained at the Pioneer Butte, Montana, office. The spreadsheet allows for simple access to all historic information. Additionally, hard copies of all laboratory reports are filed at Pioneer's Butte, Montana, office as well as at the BSB Public Works office for cross-referencing, as necessary.

A non-parametric prediction interval statistical analysis, as stipulated by DEQ in 2000 (see letter contained in Appendix E) is used to compare current monitoring data to background and baseline (intra-well) conditions.

10 REPORTING

When analytical reports are received from the laboratory for each monitoring event (typically 3 to 6 weeks following the monitoring event), the data are tabulated and subjected to a statistical analysis as described in Section 9. All information related to the monitoring event is then compiled and a letter report submitted within 90 days of sampling (to meet the requirement of a reasonable period of time as required by ARM 17.50.1305 [11], ARM, 2015a) to the DEQ Solid Waste Program and Dave Schultz at the BSB Public Works Department. This report includes the following information:

- Groundwater field parameters measured in the field;
- Copies of the field logbook entries;
- Groundwater potentiometric surface map including flow direction;
- Calculation and discussion of the groundwater flow rate;
- Statistical analysis;
- Organic analytical data reports (including QA/QC results) from Pace Laboratories in Minneapolis, Minnesota;
- Inorganic analytical data reports (including QA/QC results) from Pace Laboratories, in Minneapolis, Minnesota;
- A narrative of the sampling event noting any deviations from the SAP; and
- A comparison of the data to regulatory standards, as appropriate.

11 REFERENCES

ARM, 2015. Electronic website http://www.mtrules.org/gateway/ChapterHome.asp?Chapter=17%2E50. Montana Solid Waste Management Regulations Administrative Rules of Montana, Rule Chapter 17.50.

a. ARM 17.50.1305 (11). Ground Water Sampling and Analysis Requirements.

b. ARM 17.50.1306 Detection Monitoring Program (Appendix I to 40 CRF Part 258 [July 1, 2008].

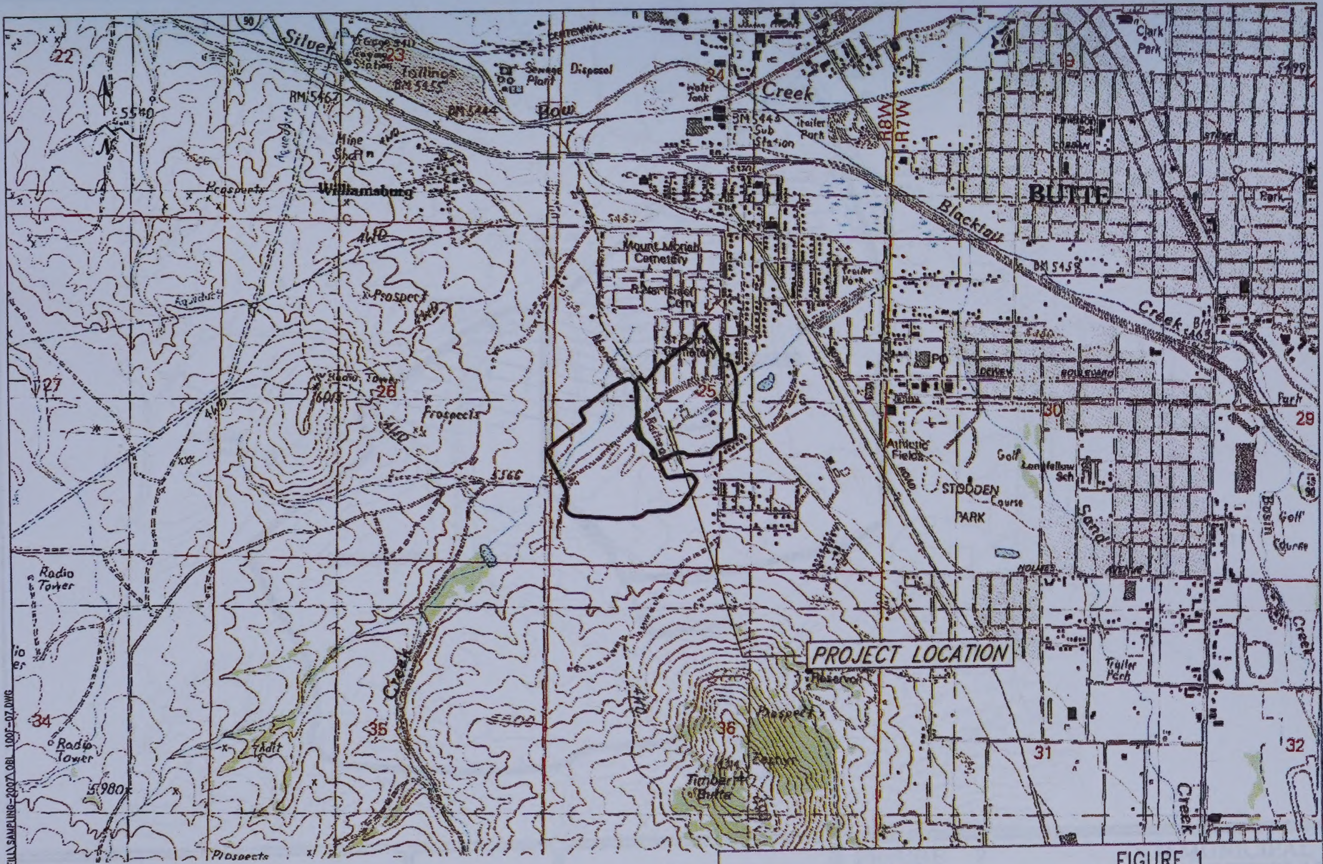
c. ARM 17.50. 1307. Assessment Monitoring Program.

Hydrometrics, 1983. Summit and Deer Lodge Valleys Long-Term Environmental Rehabilitation Study, Butte-Anaconda, Montana, Volume IV, Clark Tailings, prepared for Anaconda Minerals Company, Butte, Montana. April, 1983.

Pioneer, 1997. Final Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment. January 1997.

Smith, R., 1953. History of Early Reduction Plants of Butte, Montana, reprint from De Re Metallica, Vol. 18, Nos. 2 and 3.

FIGURES



PROJECT LOCATION
BUTTE
Williamsburg
Silver Bow Creek
Blacktail Creek
Tailings
Sewage Disposal Plant
Water Tank
Sub Station
Trailer Park
Mount Moriah Cemetery
Mine Shaft
Prospects
Prospect
Radio Tower
Aqueduct
4WD
Clark Park
Park
PO
Athletic Fields
STODDEN PARK
Golf Course
Longfellow Sch
Timber Butte
Reservoir
Adit
Creek
R8W
R7W
22
23
24
19
27
26
25
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29
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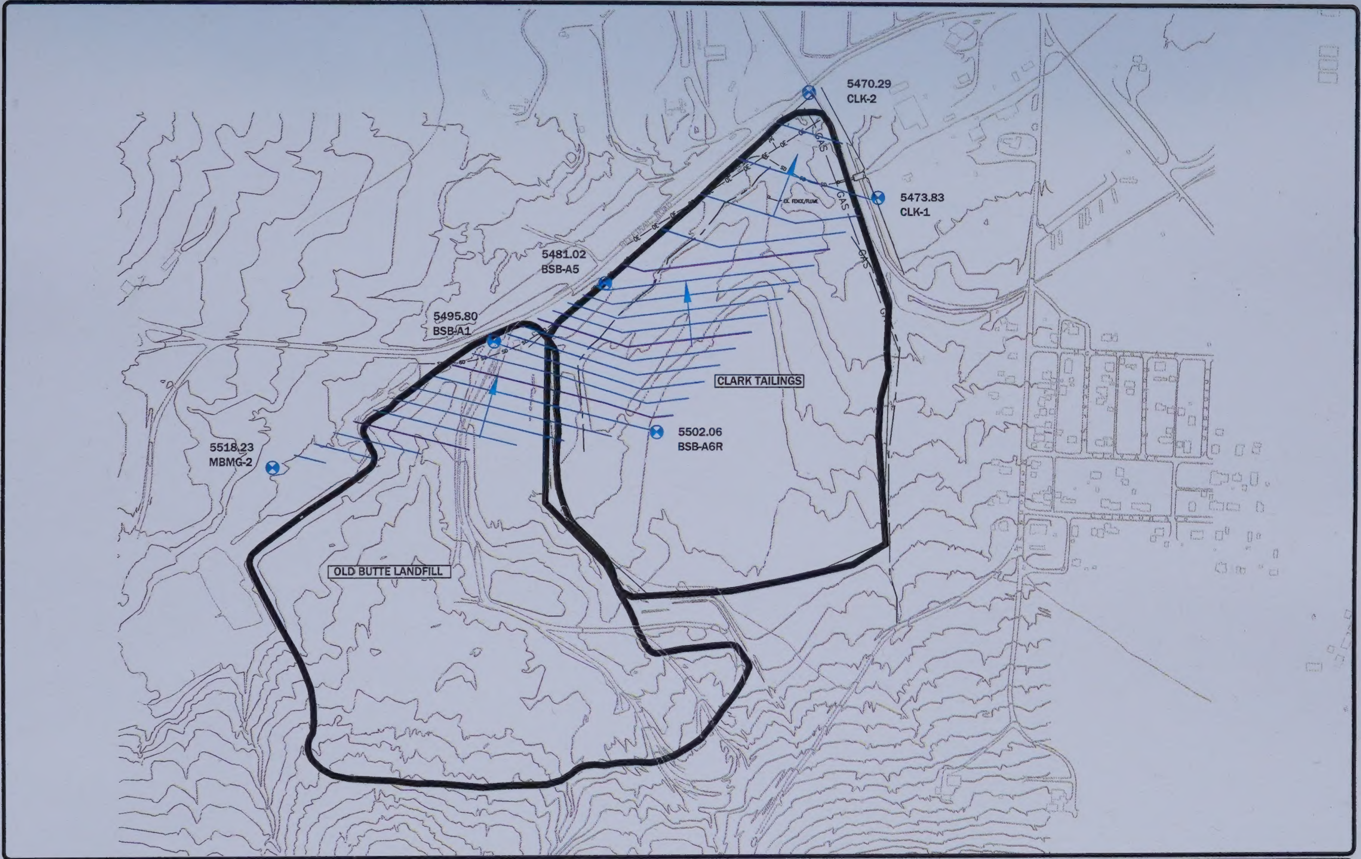
35
36
31
32
5566
5980

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2007\OBL 100F-07.DWG

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 1
GENERAL LOCATION MAP
OLD BUTTE LANDFILL SITE

SCALE: 1"=2000'
DATE: 2/14/07


5470.29
CLK-2
5473.83
CLK-1
5481.02
BSB-A5
5495.80
BSB-A1
CLARK TAILINGS
5502.06
BSB-A6R
5518.23
MBMG-2
OLD BUTTE LANDFILL
GAS
EX. FENCE/FLUME

LEGEND

CLK-1 — MONITORING WELL

CONTOUR

CONTOUR INTERVAL= 10'

N

DISPLAYED AS:

COORD SYS/ZONE: NA

DATUM: NA

UNITS: FEET

SOURCE: PIONEER

SCALE IN FEET
0 300 600

FIGURE 2

OLD MUNICIPAL LANDFILL SITE/CLARK TAILINGS FACILITY MARCH 2015

PIONEER
TECHNICAL SERVICES, INC.
63-1/2 WEST BROADWAY
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 5/29/15

5/28/2015 10:24:49 AM P:\BUTTE-SILVER BOW\BSB OLD LANDFILL\OLD LANDFILL\2015\OLDLNDFL-FG-PLN-001-15.DWG

TABLES

TABLE 1
Old Landfill Groundwater Well Information

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)[1]	TOC Elevation (ft)	Groundwater Elevation (ft)[1]
MBMG-2	BSB-GW-01	23.25	0.17	13.00	5529.88	5516.88
BSB-A1	BSB-GW-02	57.00	0.17	36.66	5531.50	5494.84
BSB-A5	BSB-GW-03	46.50	0.17	42.55	5524.62	5482.07
BSB-A6-R	BSB-GW-04	59.75	0.17	53.24	5554.41	5501.17
CLK-1	BSB-GW-05	19.00	0.17	5.03	5478.73	5473.70
CLK-2	BSB-GW-06	46.90	0.17	41.30	5511.17	5469.87

[1] As measured in September 2014

Table 3

Montana ARM 17.50.708 Table 2 Constituents

Analytical Methods, Reporting Limits, Holding Times, Preservation Method, and Container Types

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Physical Properties							
Cyanide	Distillation / Spectrophotometry	SM 4500-CN E	0.005	14 days	NaOH; pH>12, cool 4°C	500 ml Plastic / HDPE	Pace Laboratories
pH	Potentiometric	SM 4500-H+B	0.1 SU	24 hours	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Chemical Oxygen Demand (COD)	Spectrophotometry	EPA 410.4	10	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
Specific Conductance (SC)	Potentiometric	EPA 120.1	1 umhos/cm	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Inorganics (Anions)							
Chloride	IC	SM 4500-Cl E	5	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Sulfate	IC	ASTM D516	5	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Sulfide	IC	SM 4500 S2D	0.0071	7 days	NaOH/Zn Acetate, cool 4oC	500 ml Plastic / HDPE	Pace Laboratories
Nutrients							
Nitrate / Nitrite-N	Spectrophotometry	EPA 353.2	0.05	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
Dissolved Metals							
Antimony	ICP-MS	EPA 200.8	0.00025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Arsenic	ICP-MS						

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
GC/MS - Gas chromatograph/mass spectrometer
SM - Standard Methods for the Examination of Water and Wastewater
NC - No Charge

Table 3

Montana ARM 17.50.708 Table 2 Constituents

Analytical Methods, Reporting Limits, Holding Times, Preservation Method, and Container Types

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Physical Properties							
Cyanide	Distillation / Spectrophotometry	SM 4500-CN E	0.005	14 days	NaOH; pH>12, cool 4°C	500 ml Plastic / HDPE	Pace Laboratories
pH	Potentiometric	SM 4500-H+B	0.1 SU	24 hours	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Chemical Oxygen Demand (COD)	Spectrophotometry	EPA 410.4	10	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
[illegible]		[illegible]	1 umhos/cm	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
					cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
					cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
					NaOH/Zn Acetate, cool 4oC	500 ml Plastic / HDPE	Pace Laboratories
					H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
				s	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories

Please i

foldout

3

Table 3

Montana ARM 17.50.708 Table 2 Constituents

Analytical Methods, Reporting Limits, Holding Times, Preservation Method, and Container Types

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Physical Properties							
Cyanide	Distillation / Spectrophotometry	SM 4500-CN E	0.005	14 days	NaOH; pH>12, cool 4°C	500 ml Plastic / HDPE	Pace Laboratories
pH	Potentiometric	SM 4500-H+B	0.1 SU	24 hours	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Chemical Oxygen Demand (COD)	Spectrophotometry	EPA 410.4	10	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
Specific Conductance (SC)	Potentiometric	EPA 120.1	1 umhos/cm	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Inorganics (Anions)							
Chloride	IC	SM 4500-Cl E	5	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Sulfate	IC	ASTM D516	5	28 days	cool 4°C	1 Liter Plastic / HDPE	Pace Laboratories
Sulfide	IC	SM 4500 S2D	0.0071	7 days	NaOH/Zn Acetate, cool 4oC	500 ml Plastic / HDPE	Pace Laboratories
Nutrients							
Nitrate / Nitrite-N	Spectrophotometry	EPA 353.2	0.05	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	Pace Laboratories
Dissolved Metals							
Antimony	ICP-MS	EPA 200.8	0.00025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Arsenic	ICP-MS	EPA 200.8	0.00025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Barium	ICP-MS	EPA 200.8	0.00014	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Beryllium	ICP-MS	EPA 200.8	0.000066	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Cadmium	ICP-MS	EPA 200.8	0.000033	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Chromium	ICP-MS	EPA 200.8	0.00022	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Cobalt	ICP-MS	EPA 200.8	0.00025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Copper	ICP-MS	EPA 200.8	0.00022	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Iron	ICP-MS	EPA 200.8	0.008	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Lead	ICP-MS	EPA 200.8	0.000046	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Mercury	CVAAS	EPA 245.1	0.000026	28 days	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Nickel	ICP-MS	EPA 200.8	0.00023	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Selenium	ICP-MS	EPA 200.8	0.00025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Vanadium	ICP-MS	EPA 200.8	0.00021	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
Zinc	ICP-MS	EPA 200.8	0.0025	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	Pace Laboratories
VOC							
Acetonitrile	GC/MS	EPA 8260	0.00210	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Benzene	GC/MS	EPA 8260	0.00015	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Bromochloromethane	GC/MS	EPA 8260	0.00012	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Bromodichloromethane	GC/MS	EPA 8260	0.00012	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Bromoform	GC/MS	EPA 8260	0.00200	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Bromomethane	GC/MS	EPA 8260	0.00200	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Carbon disulfide	GC/MS	EPA 8260	0.00020	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Carbon tetrachloride	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Chlorobenzene	GC/MS	EPA 8260	0.000066	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Dibrochloromomethane	GC/MS	EPA 8260	0.00050	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Chloroethane	GC/MS	EPA 8260	0.00024	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Chloroform	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Chloromethane	GC/MS	EPA 8260	0.00034	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2-Dibromo-3-chloropropane	GC/MS	EPA 8260	0.00200	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2-Dibromoethane	GC/MS	EPA 8260	0.00015	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Dibromomethane	GC/MS	EPA 8260	0.00018	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2-Dichlorobenzene	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,4-Dichlorobenzene	GC/MS	EPA 8260	0.00050	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
trans-1,4-Dichloro-2-butene	GC/MS	EPA 8260	0.00500	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Dichlorodifluoromethane	GC/MS	EPA 8260	0.00050	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1-Dichloroethane	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2-Dichloroethane	GC/MS	EPA 8260	0.00013	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1-Dichloroethene	GC/MS	EPA 8260	0.00020	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
cis-1,2-Dichloroethene	GC/MS	EPA 8260	0.00013	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
trans-1,2-Dichloroethene	GC/MS	EPA 8260	0.00023	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2-Dichloropropane	GC/MS	EPA 8260	0.00014	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
cis-1,3-Dichlopopropene	GC/MS	EPA 8260	0.00013	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
trans-1,3-Dichloropropene	GC/MS	EPA 8260	0.00018	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Ethylbenzene	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
2-Hexanone	GC/MS	EPA 8260	0.00250	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Iodomethane	GC/MS	EPA 8260	0.00200	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
methylene chloride	GC/MS	EPA 8260	0.00200	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Styrene	GC/MS	EPA 8260	0.000063	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1,1,2-Tetrachloroethane	GC/MS	EPA 8260	0.00050	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1,2,2-Tetrachloroethane	GC/MS	EPA 8260	0.00050	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Tetrachloroethene	GC/MS	EPA 8260	0.00016	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Toluene	GC/MS	EPA 8260	0.00011	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1,1-Trichloroethane	GC/MS	EPA 8260	0.00026	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,1,2-Trichloroethane	GC/MS	EPA 8260	0.00013	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Trichloroethene	GC/MS	EPA 8260	0.000091	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Trichlorofluoromethane	GC/MS	EPA 8260	0.00022	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
1,2,3-Trichloropropane	GC/MS	EPA 8260	0.00120	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Vinyl acetate	GC/MS	EPA 8260	0.00021	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Vinyl chloride	GC/MS	EPA 8260	0.00020	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
m+p-Xylenes	GC/MS	EPA 8260	0.00031	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
o-Xylene	GC/MS	EPA 8260	0.000094	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories
Xylenes, Total	GC/MS	EPA 8260	0.00040	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Pace Laboratories

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
GC/MS - Gas chromatograph/mass spectrometer
SM - Standard Methods for the Examination of Water and Wastewater
NC - No Charge

Table 4
Groundwater Monitoring Field Equipment List
Butte-Silver Bow Landfill

SAMPLING SUPPLIES

Field Sampling Plan
Pioneer SOP's
Logbook
Field Parameter Data Form
Pens
Sharpies
Clipboard
Cooler
Ice
Sample Containers
Preservatives
Sample Labels
Clear Packing Tape
Gallon Plastic Resealable Bags
Chain of Custody Forms
Chain of Custody Seal
Packing Material
Keys for Wells
Electronic Depth to Water Meter
De-ionized Water
Spray bottle with DI water
Calibration solutions
Ph Meter 1 Meter
SC Meter required for
DO Meter these
EH Meter

12 volt Variable speed Stainless steel pump
12 Volt submersible pump
Optional: 12 volt battery
Dedicated tubing
Extra Bailer
Bailing String
Nut wrench or flat head screwdriver
Hose Clamps
Nitrile Gloves
Extra Large Binder Clips
Bucket
Stopwatch or cell phone
Scissors or knife
Beaker or Flow through block
Filters
Extra Batteries for Meters
Paper Towels
Blank Water
Jugs with water for decontamination of pumps
Containers for decontamination of pumps
Containers for containing purge water
Duct tape

SAFETY SUPPLIES/PPE

Health and Safety Plan
First Aid Kit
Fire Extinguisher
Leather Gloves
Nitrile Gloves
Steel Toed Boots
Safety Glasses
Sunscreen
Insect Repellent
Drinking Water
Hearing Protection (if required by generator use)

Appendix A

DEQ Memorandum, SRS Low-Flow Purging and Sampling Guidelines

Memorandum

To: DEQ SRS

From: Amy Sivers

Date: 4/18/2005

Re: **SRS Low-Flow Purging and Sampling Guidelines**

The following guidelines provide the basis for low-flow sampling protocol at Montana Department of Environmental Quality (DEQ) Site Response Section (SRS) facilities, unless site-specific and contaminant-specific conditions require alternate protocols be followed. If alternate protocols are proposed, the sampler must provide a detailed written justification for the deviation from these guidelines. If the sampler is other than DEQ, the sampler must obtain DEQ approval prior to commencing a low-flow sampling event or program. If the sampler implements a deviation from these guidelines, such deviation must be documented in writing where the resulting data are discussed, for example in the site investigation (SI) report or monitoring report, and also in the field log book or groundwater sampling log.

Low-flow sampling purges stagnant water out of the well to allow sampling of formation water; however it is intended to purge and sample only a limited interval of the well/formation column.

Applicability of Guidelines:
"Low-flow" purging and sampling is also called "minimum drawdown" and "low-stress" purging and sampling. This SRS guidance does not cover minimum-purge or no-purge sampling.

Guidelines:

1) Low-flow sampling is generally not appropriate for wells that contain light or dense non-aqueous phase liquids (LNAPL or DNAPL), and is not appropriate for collecting samples of LNAPL or DNAPL.
2) A positive displacement pump that allows for an adjustable pumping rate should be used for low-flow groundwater sampling under most conditions
    a. Suction pumps, such as peristaltic pumps, are inappropriate for collecting volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), volatile petroleum compounds and some (pH-dependent) metals, particularly in wells deeper than 10-15 feet, because of the potential for degassing and associated potential pH changes.

   b. Inertial pumps (such as Waterra) or bailers should never be used for low-flow sampling because they generate turbulence in the well.
   c. Dedicated pumps are preferable to portable pumps. Portable pumps may create disturbance in the water column during installation, and also require decontamination between wells.
   d. If a portable pump is used, new or dedicated tubing must be used at each sampling location, and the pump must be lowered gently into the well to minimize disturbance to the water column.
3) If a petroleum-powered generator is used to run the sampling pump, the power source must be located at least 10 feet downwind of the wellhead and sampling apparatus, and should be located at least 30 feet downwind if possible.
4) Pump intake must be in an appropriate location with respect to well screen.
   a. For most sites, and at wells with screens 10 feet long or shorter, the pump intake should be located at approximately the midsection of the saturated screened interval.
   b. For wells with screens longer than 10 feet, the primary flow zones and contaminant concentration intervals must be identified and pump intake location must be determined in consultation with SRS.
   c. For sites with intervals of different contaminant concentrations within the well screen, the pump intake should be located in the most contaminated interval.
      i. For example, at sites with LNAPLs, such as gasoline-type petroleum contamination, it may be appropriate to collect groundwater samples from the upper portion of the saturated screened interval. However, the pump intake and pumping rate must not allow drawdown of the water level to the level of the pump intake.
      ii. At sites with DNAPLs as sources of groundwater contamination, it may be appropriate to locate the pump intake in the lower portion of the well; however, the pump should not be placed in the lower two feet of the well if possible, so as to avoid disturbing sediment.
   d. For fractured bedrock sites and other sites with preferential contaminant flow pathways, the pump intake should be placed to sample the most hydraulically conductive interval, unless the sampling objective is to sample a different flow path.
5) Low-flow sampling is designed to achieve laminar groundwater flow through the well screen and into the pump intake. This sampling technique therefore requires knowledge of well construction and lithology surrounding the well, and it requires that the well be in good condition. Therefore if well construction information is unavailable, or screen silting/biofouling or other well construction issues have been observed, the well in question should not be used for low-flow sampling. Re-development of site wells is advisable prior to introducing low-flow sampling, particularly if wells are more than five years old.

6) Pump tubing must be appropriate for the analytes to be sampled. Certain types of plastic tubing can either sorb contaminants from sample water or contribute contaminants to sample water as it flows through the tubing.
    a. Teflon, Teflon-lined and steel tubing is preferred for sampling for organic compounds including VOCs, SVOCs, petroleum, pesticides and PCBs. If other tubing is used for these analytes, an equipment blank should be used to check that contaminants are not being added to the water, and SRS may require that a 'spiked' solution be run through the tubing to check for sorbtion.
    b. In addition to Teflon and Teflon-lined tubing, PVC, polypropylene or polyethylene tubing is also appropriate for metals sampling. Stainless steel tubing is not appropriate for collecting metals samples, although equipment blanks may demonstrate whether or not there is an effect.
    c. The smaller the diameter of tubing used, the easier it will be to maintain low flows without getting air bubbles in the tubing.
    d. Maximize tubing wall thickness and minimize tubing length to minimize diffusion between water and the atmosphere.
    e. If a peristaltic pump is used for low-flow sampling (see #2 above), pharmaceutical grade ("pharmed") tubing should be used around the rotor head of the pump to avoid diffusion to/from the atmosphere.
7) Pump rates for low-flow sampling should generally not exceed 0.3 liters/minute. Aquifers with particularly high conductivity may be able to sustain higher flow rates with laminar flow into the well and without excessive drawdown.
8) Initial depth to water must be measured prior to starting the water pump. Depth-to-water measurements must be collected frequently during purging and sampling and recorded in the sampling log; depth to water is typically measured at the same frequency as stabilization parameters are measured. Depth to water may be measured using an air-water interface probe, or a transducer located above the pump. If a transducer is used it must be 'truthed' at the start and end of sampling using an interface probe. Depth to water measurements should have minimum 0.01-foot accuracy. Care should be taken when inserting measurement devices into the well to avoid disturbance to the water column.
9) Total well depth should never be measured at the start of the low-flow sampling event, because this causes disturbance of the water column in the well. Instead, total well depth should be measured in advance of the sampling event, and may be re-measured after completion of a low-flow sampling event.
10) Initial drawdown should ideally not exceed 0.3 feet; however, initial drawdown in excess of 0.3 feet may be allowed if the water level stabilizes after that initial drawdown. If the water table is initially above the top of the well screen, then the water level should not be allowed to drop below the top of the well screen during purging and sampling. Also, total dewatering is never acceptable in low-flow sampling – if low-flow purging causes total dewatering, passive samplers may be an appropriate alternate sampling methodology.

11) Pumped water should flow through an in-line water quality meter such as a flow-through cell. Stabilization parameters should be decided on a site-specific basis, dependent on site geochemistry and other factors, with the following understanding:
    a. Field indicator parameters for stabilization include turbidity, dissolved oxygen, specific conductance, and redox potential. Temperature may also be recorded during well purging. Stabilization criteria should be those established in the EPA document ORD/OSWER EPA/540/S-95/504 as referenced at the end of this document.
    b. The key stabilization parameter for VOC sampling is dissolved oxygen, which should stabilize to three consecutive readings within 10% of each other (this is a 10% difference between the magnitudes of the readings, and not 10% DO in the samples), OR within 10% of 0.2 mg/L, whichever is greater. SRS may require that additional stabilization parameters be monitored.
    c. The key stabilization parameter for other contaminant sampling is turbidity, which should stabilize to three consecutive readings within 10% of each other, OR three consecutive readings below 10 Nephelometric Turbidity Units NTU, whichever is greater. SRS may require that additional stabilization parameters be monitored.
12) Stabilization parameters should be measured on a three- to five-minute frequency; where a flow-through cell is used, complete exchange of water through the flow-through cell is necessary between measurements. The proposed work plan/SAP/SOP for low-flow sampling must state the frequency of stabilization parameter measurements.
13) Samples should be collected after indicator parameters have stabilized. When more than one sample type is to be collected from the well, samples should be collected in order from most volatile to least volatile analytes.
    a. The pump should not be moved or turned off between purging and sampling.
    b. The pump rate may be decreased for sample collection in order to allow filling of sampling containers (this is often necessary to fill VOC sampling vials).
    c. Note – as in all groundwater sampling, make sure the flow-through cell is bypassed during sample collection.
14) If parameters do not stabilize, either:
    a. the well should be purged for a minimum of four hours prior to sampling, or
    b. a minimum of three well volumes should be evacuated from the well prior to sampling, or
    c. the sampler should discontinue purging and not collect a sample.

If a sample is collected, lack of stabilization of parameter values should be documented in the field logbook. Whether to allow sampling when parameter stabilization is unattainable is a site-specific and contaminant-specific decision.

Site-specific decisions:

Many decisions about protocol for low-flow sampling must be made on a site-specific basis. These include any proposed exceptions to the guidelines above, and the following additional requirements:

- QA/QC requirements
- Decontamination requirements – for portable pumps, dedicated pumps, dedicated tubing
- Condition of existing on-site wells and need for re-developing or replacing old wells
- Stabilization parameters and stabilization criteria
- Sample collection at wells where parameters do not stabilized after purging
- Field filtering requirements for any samples
- How to compare low-flow data to existing non-low-flow site data (VOCs may increase because of lower mixing, agitation, etc; metals, PAHs and other particulate-associated COCs may decrease due to less suspended sediment in the sample) – whether to require contemporaneous side-by-side sampling using low-flow and traditional methods to compare data, or whether to compare low-flow data to historical site data.

References:

Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures – Puls, R.W. and Barcelona, M.J. (April 1996) – EPA ORD/OSWER EPA/540/S-95/504

Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples From Monitoring Wells – EPA Region 1 (July 30, 1996) EPA R1 SOP# GW 0001.

Standard Operating Procedure for Low-Stress (Low Flow) / Minimal Drawdown Groundwater Sample Collection – EPA Region 9 (undated) EPA R9

Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling – EPA Region 2 (March 16, 1998) GW Sampling SOP Final.

Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling (2nd ed.) – Nielsen, D.M. and Nielsen, G.L. (April 2002) – Nielsen Environmental Field School, NEFS-TG001-02.

PTS-SOP-GW-10-LF

STANDARD OPERATING PROCEDURE
PURGING AND SAMPLING WITH A LOW FLOW SUBMERSIBLE PUMP

1. Using clean, non-contaminating equipment, e.g., an electronic level indicator (avoid indicating paste or chalk), determine the water level in the well.

2. Attach the appropriate disposable tubing to the pump outlet. (Note also that all down-hole and potentially wetted surfaces must also be non-contaminating/noncontributing. This includes power and suspension cables and compressed gas or sample tubing.)

3. Lower the pre-cleaned pump and tubing gently to approximately midsection of the saturated screened interval and begin pumping. Monitor draw down of the water table with an electrical level indicator, initial drawdown should ideally not exceed 0.3 feet; however, initial drawdown in excess of 0.3 feet may be allowed if the water level stabilizes after the initial drawdown.

4. Set the controls on the pump for the appropriate discharge rate, in general this would be between .25 and .5 liters a minute. Frequently measure the rate of discharge, a bucket or liter bottle and stopwatch are commonly used.

5. Collect or dispose of purged water in an acceptable manner.

6. Purge until discharge pH, conductivity, or temperatures have stabilized. Water quality parameters taken at approximately 3 to 5 minutes will be considered stable when three consecutive readings are as follows:

   - Temperature range is no more than +/- 1 degree Celsius (°C);
   - pH varies by no more than 0.2 pH units; and
   - Specific conductivity readings are within 10% of the average.

7. After field parameters have stabilized, fill necessary bottles by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled.

8. Select appropriate sample bottles and preserve the sample if necessary.

9. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

10. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Complete chain-of-custody documents and field logbook.

FIELD SAMPLE DATA SHEET

Page __ of __

Project Name: Old Landfill Groundwater Monitoring

WELL/STATION ______ ________________ DATE ________________ TIME ______________

SAMPLERS ________________ WEATHER CONDITIONS ____________________

PHOTO: Yes ______ No _____ ROLL# ______ NUMBER _________

PURGE DATA:

PURGE METHOD _________________________

START PURGING ________________

PURGE RATE ________ GPM

RATE CHANGE 1) Time ______ Rate _________

2) Time ______ Rate _________

SAMPLE TIME ________________

WELL DEPTH ________ Feet

DEPTH TO WATER ________ Feet

COLUMN DEPTH ________ Feet

CASING DIAMETER ________ Inch

PUMP SET AT ________ Feet

3 WELL VOLUMES ________ Gallons

TOTAL PURGE VOLUME ________ Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
	1 Liter		HNO_3	Dissolved Metals-
	1 Liter			
	1 Liter			
	1 Liter			
	1 Liter			

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: ____

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Appendix B

Pioneer Groundwater Monitoring, Standard Operating Procedures

PTS-SOP-DE-01
September 2011

STANDARD OPERATING PROCEDURE
PERSONNEL DECONTAMINATION PROCEDURES

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection.

PROTECTION:

1. Follow personal protective measures outlined in the site-specific Health and Safety Plan.
2. In the event that personnel decontamination becomes necessary, the outer more heavily contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
3. Next, the inner, less contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
4. Store the items separately so they are used in contaminated areas only.
5. For contaminants other than those found typically at uncontrolled hazardous waste sites, see the Health and Safety Officer.

EMERGENCY DECONTAMINATION:

1. If the decontamination procedure is essential to the life-saving process, decontamination must be performed immediately.
2. If heat related illness develops, protective clothing should be removed as soon as possible.

WASH, RINSE AND/OR CUT OFF PROTECTIVE CLOTHING/EQUIPMENT

3. If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. Wrap the victim to reduce contamination of others.
4. Alert medical personnel to the emergency and instruct them about potential contamination. Instruct medical personnel about specific decontamination procedures.
5. Dispose contaminated clothing and equipment properly.

PTS-SOP-DE-02

STANDARD OPERATING PROCEDURE
EQUIPMENT DECONTAMINATION

All equipment leaving the contaminated area of a site must be decontaminated. Decontamination methods include physical removal, chemical removal or a combination of both. Decontamination procedures, in some cases, are to be performed in the same level of protection used in the contaminated area of a site. However, decontamination personnel may be sufficiently protected by wearing one level lower protection. The following decontamination procedures are for typical uncontrolled hazardous waste sites. For a more specific or unusual contaminant such as dioxins, see the site-specific Health and Safety Plan. Decontamination procedures should be used in conjunction with methods to prevent contamination of sampling and monitoring equipment.

INORGANIC CONTAMINANTS - HEAVY METALS:

1. Remove gross contamination with a water rinse using pressurized or gravity flow tap water.
2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.
3. Rinse the equipment with tap water.
4. Rinse the equipment with distilled water.
5. Rinse the equipment with a mixture of 10:1 nitric acid in distilled water (10 parts water to 1 part nitric acid).
6. Rinse the equipment again with distilled water.

ORGANIC CONTAMINANTS:

1. Remove gross contamination physically with a disposable paper towel or with a water rinse using pressurized or gravity flow.
2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.
3. Rinse the equipment in tap water.

4. Rinse the equipment with deionized water.

5. Rinse the equipment with methanol.

EQUIPMENT USED FOR DECONTAMINATION:

1. Rinse equipment (brushes, buckets, tubs) used in the decontamination process with water, preferably pressurized.

2. Agitate the equipment used in the decontamination process in the soap/tap water solution. (The tub which holds the solution will only have the water rinse.)

3. Rinse equipment with tap water.

4. Place equipment in appropriate areas, so they are used only for decontamination purposes (label if necessary).

DISPOSAL OF DECONTAMINATION SOLUTIONS:

1. Proper disposal of the soap/tap water solution, the tap water rinse, and the deionized water rinse is to a proper waste water container.

2. Proper disposal of the solvent rinse is to a proper organic solvent waste container.

3. When contaminants have been identified, either in the solutions or elsewhere on the site, solutions should be disposed of appropriately. If they are hazardous (characteristic, listed, etc.) dispose of them as such.

4. WHEN USING OTHER THAN THE ABOVE MENTIONED SOLUTIONS, BE SURE TO CHECK WITH THE HEALTH AND SAFETY OFFICER AND THE PROJECT MANAGER. SOME SOLVENTS MUST BE EVAPORATED.

EFFECTIVENESS OF DECONTAMINATION:

1. Effectiveness of the decontamination procedures will be measured using field equipment rinsate blanks (see the site-specific Quality Assurance Project Plan).

PTS-SOP-DE-03

STANDARD OPERATING PROCEDURE
INVESTIGATION DERIVED WASTE HANDLING

During a Site Assessment (SA), Site Investigation (SI), or Remedial Investigation (RI) process investigation derived wastes may be generated. The following is the method for handling investigation-derived waste in accordance with EPA protocols and DEQ guidance:

1. Decontamination fluids will be collected and then disposed of by either sending to a TSD, evaporated, treated using an activated carbon or air sparging unit, or temporarily stored until determined if it is contaminated. Decontamination fluids generated from cleaning equipment used in background sampling or for sampling in areas where past results indicate that contaminants are below standards, will be disposed of to the ground surface.

2. Groundwater generated from developing and purging monitoring wells will be discharged to the ground surface if past monitoring results indicated that all contaminants were below groundwater standards. If past monitoring results indicated that one or more contaminants were above groundwater standards, the purged water and potentially contaminated water will be collected. If the water is determined to be below standards by laboratory analysis it will be discharged to the ground surface. There may be instances (i.e. inclimate weather) where purge water and/or decon water will be temporarily stored in drums or tanks to be treated on-site with granulated activated carbon or air sparging. If the water is determined by laboratory analysis to contain contaminants above groundwater standards and can not be treated on-site it, it will be stored on-site until shipping/disposal arrangements can be made. If the water is visibly contaminated it will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. All containers stored on-site will be labeled with the date, time, contents, any corresponding analytical data, collection location, contact person, contact agency, etc.

3. Soil and or cuttings from monitoring well installation will be placed back in the borehole unless it is visibly contaminated. If the soil is visibly contaminated the soil/cuttings will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. Soils from borings/well installations located in previously sampled areas that are known to be contaminated will be drummed, labeled, and left on-site until shipping/disposal arrangements are made.

4. Disposable equipment intended for one-time use and personal protective equipment (PPE) materials will be packaged for appropriate disposal. The disposable equipment and PPE utilized for sampling will be double bagged and disposed of as a solid waste in the local landfill. Disposable equipment and PPE utilized for sampling visibly contaminated sites or sites known to be contaminated from previous monitoring will

be packaged, drummed, labeled and left on-site until shipping/disposal arrangements are made.

5. Laboratories will dispose of the portions of the samples not used for analysis.

Personnel will decontaminate all equipment prior to sampling and before leaving the site, to prevent off-site contamination, in accordance with PTS-SOP-DE-02. Equipment decontamination will consist of a tap water rinse, soap and water wash, distilled water rinse, and air drying. If appropriate, additional rinses may be needed in association with decontamination procedures for specific contaminants (i.e., dilute nitric rinse for equipment used in sampling for metals, a methanol rinse for equipment used in sampling for certain organics).

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection. Personnel must follow the Personnel Decontamination Procedure PTS-SOP-DE-01.

PTS-SOP-SA-01
September 2011

STANDARD OPERATING PROCEDURE
SOIL AND WATER SAMPLE PACKAGING AND SHIPPING

1. WATER SAMPLE PRESERVATION precedes if the sample to be packed is water and preservation is required.

2. Each of the filled sample containers will be placed in separate ziplock bags to keep it clean, dry, isolated, and to protect the sample label. Samples will then be placed in a cooler which has been lined with a plastic bag. The samples will be surrounded with vermiculite to reduce movement and absorb any leakage. Ice will be placed in the cooler. The plastic bag will then be tied to contain the vermiculite and ice.

3. The Project Manager will double check the paper work (chain-of-custody form, etc.) to assure those samples recorded on the associated paper work are in the cooler. The Project Manager and the sampler will then sign the chain-of-custody form to relinquish custody.

4. The paper work will then be placed in a sealed ziplock bag and taped to the inside of the cooler lid.

5. The cooler will be labeled with the appropriate shipping labels (NOS, flammable liquids, flammable solids, this side up, fragile, etc.).

6. The cooler will then be closed and an address label will be affixed to the lid (a Federal Express label will also be affixed, if used, at this time).

7. The cooler will then be closed and chain-of-custody seals will be placed over the opening.

8. Tape will then be placed over the custody seals and around the cooler.

9. The cooler(s) will then be transported to a secure storage, to the shipping agent, or directly to the laboratory.

Note: Bagging of samples and lining of coolers will not be necessary if samplers transport samples directly to the laboratory.

PTS-SOP-SA-02

STANDARD OPERATING PROCEDURE
SAMPLE PRESERVATION AND CONTAINERIZATION FOR AQUEOUS SAMPLES

This SOP describes the techniques and quality control measures used to sample, prepare, and handle water containing the analytes listed below:

- Target Analyte List;
- Total Recoverable Metals;
- Cyanide;
- Sulfate;
- Nitrate/Nitrite;
- Chloride;
- Hardness;
- Pentachlorophenol;
- Dioxins/Furans; and
- Extractable Petroleum Hydrocarbons.

TARGET ANALYTE LIST:

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be acidified with dilute nitric acid (1 to 1) to a pH of 2 or less. Normally, 3 milliliters (ml) of dilute nitric acid per liter should be sufficient to preserve the samples. This will keep the metals in solution and minimize their absorption on the container wall.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within six months of collection. An exception is mercury (Hg) analysis, which must be completed in 28 days.

5. Serious errors may result during sampling and storage by failure to follow these guidelines.

TOTAL RECOVERABLE METALS

1. Follow the procedure outlined for the Target Analyte List.

CYANIDE

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be preserved with dilute sodium hydroxide (NaOH) to a pH of greater than 12 or higher.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within 12 days of collection.

SULFATE, CHLORIDE, HARDNESS

1. Because these four parameters can be analyzed together, one 1-Liter polyethylene or glass bottle will be required from the contract laboratory.

2. Upon sample collection and sample labeling and storing (as per PTS-SOP-SA-01), the sample should be stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

4. In the presence of organic matter, certain bacteria may reduce sulfate to sulfide. To avoid this, samples will be stored at or below 4°C.

NITRATE/NITRITE

1. A 250 ml polyethylene bottle is required for this analysis.

2. Upon sample collection, the sample should be acidified with sulfuric acid (H_2SO_4) to a pH of 2 or less and promptly stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

PENTACHLOROPHENOL

1. A 2,360 ml amber glass jug is required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 °C until analysis.

3. All samples must be analyzed within 14 days of collection.

DIOXIN/FURANS

1. A 1,000 ml amber glass bottle will be required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 °C until analysis.

3. Samples must be extracted within 10 days of collection.

EXTRACTABLE PETROLEUM HYDROCARBONS (EPH)

1. Two 1,000 ml glass bottles are required for this analysis.
2. Upon sample collection, each bottle should be acidified with hydrochloric acid (HCL) to a pH of 2 or less and promptly stored at 4 °C until analysis.
3. All samples must be analyzed within 14 days of collection.

PTS-SOP-SA-02b

STANDARD OPERATING PROCEDURE
SAMPLE PRESERVATION, AND CONTAINERIZATION FOR AQUEOUS SAMPLES

This SOP describes the techniques and quality control measures used to sample, prepare, and handle water containing the analytes listed below:

- Volatile Organic Compounds (VOC's);
- Semivolatile Organic Compounds (SVs);
- Pesticides/PCB's

VOLATILE ORGANIC COMPOUNDS:

1. Two 40-ml glass vials with a Teflon lined septum cap will be required from the contract laboratory.

2. Prior to sample collection, the sample is to be preserved by adding 1-ml of concentrated HCI to the vial. Alternatively, the vials may be supplies by the lab with the HCI preservative already in the vials. This will eliminate biological activity and the potential for biodegradation of the COCs.

3. Add sample water to the container slowly and with a minimum of aeration or disturbance, initially running down the side of the vial rather than dropping to the bottom. This is necessary to protect the integrity of the sample's volatile constituents. After the vial is filled, continue to add sample water until a meniscus is formed at the top, above the top of the vial. Hold the vial vertically and still for several seconds to allow any air bubbles to dissipate; gentle tapping of the vial may be required. Carefully place the cap on the mouth of the vial and screw the cap down.

4. Invert the vial and tap firmly to verify that no air bubbles are trapped in the container. If air bubbles are observed, discard the sample and resample using a new vial.

5. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

6. All VOC samples should be analyzed with in 14 days of collection.

PTS-SOP-SA-03

STANDARD OPERATING PROCEDURE
FIELD QUALITY CONTROL SAMPLES

Field quality control (QC) is a part of the Project Quality Assurance/Quality Control (QA/QC) program and is described in detail in the site-specific Quality Assurance Project Plan. This SOP describes the preparation and collection frequency of field QC blanks and duplicate samples from water media.

At least one set of field QC samples will be prepared for each sampling event. QA/QC samples will be collected at a frequency of 1:20. If the number of field QC samples taken is not equal to an integer multiple of the interval, then the next higher multiple will be used. For example, if a frequency of 1:20 is indicated and 28 samples are taken, then two QC samples will be prepared.

All field QC samples shall be shipped with field samples to the contract laboratory as per PTS-SOP-SA-01.

One field bottle blank will be required at 1:20 and as follows:

> A bottle blank is a sample bottle containing DS/DI water and preservatives and is prepared in the field. It is contained in a sample bottle randomly chosen from each lot of bottles received by the contract laboratory or supplier. A bottle blank is prepared by the same protocols as a normal sample, but is not exposed to any "field conditions" or sampling equipment. The appropriate sample number shall be placed on the bottle.

One field duplicate will be taken 1:20 and as follows:

> A field duplicate consists of two samples taken at the same location and time, but placed in different bottles for separate analysis. Each duplicate shall be analyzed for identical chemical parameters.

1. Collect an adequate volume of sample to accommodate two sample bottles.

2. Process the samples (as per SOPs) for each duplicate.

3. Label the two sample bottles with appropriate sample numbers.

4. Record duplicate number, sample number, and sample location in the field log book.

PTS-SOP-SA-04
September 2011

STANDARD OPERATING PROCEDURE
CHAIN OF CUSTODY FORMS FOR ENVIRONMENTAL SAMPLES

This SOP establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of sample at the analytical laboratory. This procedure shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigations by Pioneer Technical Services, Inc. (Pioneer). It is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.

Chain of custody is an unbroken trail of accountability that ensures the physical security of samples, data and records. Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met if the samples are:

- in the responsible individual's physical possession;
- in the responsible individual's visual range after having taken possession;
- secured by the responsible individual so that no tampering can occur; or
- secured or locked by the responsible individual in an area in which access is restricted to authorized personnel.

RESPONSIBILITIES

PROJECT MANAGER:

1. The Project Manager is responsible for overall management of environmental sampling activities, designating sampling responsibilities to qualified personnel, and reviewing any changes to the sampling plan.

FIELD TEAM LEADER:

1. The Project Manager may act as the Field Team Leader or may choose to appoint a Field Team Leader.
2. The Field Team Leader is responsible for general supervision of field sampling activities and ensuring proper storage/transportation of samples from the field to the analytical laboratory. Chain of Custody forms will be reviewed for accuracy and completeness to preserve sample integrity from collection to receipt by an analytical lab. Review of Chain of Custody forms may be delegated to qualified personnel. The Field Team Leader is responsible for sample custody until the sample has been properly relinquished as documented on the chain of custody form.

FIELD SAMPLER

1. The Field Sampler is responsible for sample acquisition in compliance with technical procedures, initiating the Chain of Custody, and checking sample integrity and documentation prior to transfer.

2. Field samplers are also responsible for initial transfer of samples consisting of physical transfer of samples directly to the internal laboratory or transferred to a shipping carrier, (i.e., United Parcel Service or Federal Express) for delivery.

LABORATORY TECHNICIAN

1. The receiving Laboratory Technician is responsible for inspection of transferred samples to ensure proper labeling and satisfactory sample condition.
2. Unacceptable samples will be identified and segregated. The Environmental Manager will be notified.
3. The Laboratory Technician will review the Chain of Custody for completeness and file as part of the project's permanent record.

EQUIPMENT AND MATERIALS

- Seals and Labels;
- Chain of Custody forms (provided by contracted laboratory); and
- Packing and shipping materials as necessary.

1. All samples shall be collected and handled in accordance with PTS-SOP-SA-01 and PTS-SOP-SA-02, or other methods, if appropriate. Samples will be transported in insulated coolers with ice ('blue ice' is acceptable) as necessary to maintain temperature at 4° C+/- 2°C until receipt by the analytical laboratory.

2. The Field Team Leader or designated Field Sampler shall initiate the Chain of Custody form for the initial transfer of samples.

3. A Chain of Custody form will be completed and accompany every sample. The form includes the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;
- Analysis requested;
- Remarks;
- Relinquishing signature, data, and time; and
- Receiving signature, date, and time.

4. The Field Sampler relinquishing custody and the responsible individual accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form. (If the transporter is not an employee of Pioneer, the Field Sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature.)

5. One copy of the Chain of Custody form shall be filed as a temporary record of sample transfer by the Field Sampler. The original form shall accompany the samples and

shall be returned to Pioneer as part of the contracted laboratory Quality Assurance/Quality Control (QA/QC) requirements. The original form will be filed as part of the project's permanent records.

6. The Project Manager (or designee) shall track the Chain of Custody to ensure timely receipt of samples by an analytical laboratory.

PTS-SOP-SA-05

STANDARD OPERATING PROCEDURE
PROJECT DOCUMENTATION

This SOP establishes the requirements for documenting and maintaining field logbooks and photographs. These procedures shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigation by Pioneer Technical Services, Inc. (Pioneer). These procedures apply from the time field work begins until site activities are completed.

RESPONSIBILITIES

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written ink. The author will initial and date entries at the end of each day. All corrections will consist of a single line-out deletion in ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks shall include the following entries:

1. A description of the field task.
2. Time and date fieldwork started.
3. Location and description of the work areas, including sketches if possible, map references and photographs, and sketches of well construction details.
4. Names and titles of field personnel.
5. Name, address, and phone number of any field contacts or site visitors
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions.
7. Details of the fieldwork performed and field data sheets used with special attention to any deviation from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures.
8. All field measurements made.
9. Any field laboratory analytical results.
10. Personnel and equipment decontamination procedures.

For any field sampling work the following entries should be made:

1. Sample location and number.
2. Sample type and amount collected.
3. Date and time of sample collection.
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, and any other pertinent information.
5. Sampling method, particularly any deviations from the SOP.
6. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample.

7. Sample preservation, handling, packaging, labeling, and the laboratory where the samples will be sent.

Photographs will be taken of field activities using a camera-lens system or a digital camera system. Photographs should include a scale in the picture when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced.
2. A brief description of the subject and the fieldwork portrayed in the picture.
3. Sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives shall be placed in task files in the field office after the film is developed. Any supporting documentation from the bound field logbooks shall be photocopied and placed in the task files to accompany the particular slides or prints.

PTS-SOP-WFM-01

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH IN WATER

INSTRUMENT CALIBRATION:

Calibrate pH meter in the field at the beginning of each day of field work and when the standard check is out of calibration. Recheck calibration at end of day.

1. Rinse the ATC pH probe in deionized water.

2. Turn on meter and immerse the ATC pH probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize.

3. Rinse ATC pH with deionized water.

4. Immerse ATC pH probe in a pH 4 buffer solution Calibrate meter to pH 4 allowing enough time for meter to stabilize.

5. Rinse pH and temperature probe with deionized water.

6. Immerse ATC pH probe in a pH 10 buffer solution. Calibrate meter to pH 10 allowing enough time for meter to stabilize.

7. Record the slope reading in the field logbook.

8. Recheck meter calibrations with the pH4, pH 7 and pH 10 calibration solutions. Repeat the calibration process (Steps 2-4) if values for any of the final pH check is more than 0.1 units from the appropriate value.

FIELD PROCEDURES:

1. Rinse beaker with sample water three times.

2. Rinse ATC pH probe with deionized water.

3. Fill beaker with sample water.

4. Turn on meter and immerse ATC pH probe in sample water. Stir sample for thorough mixing. Read and record pH to nearest 0.01 unit once pH reading has stabilized.

5. Rinse electrodes with deionized water and store in carrying case.

Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnant water.

PTS-SOP-WFM-02

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF EH IN WATER

Redox-Potential (EH) measurements are performed using ORION model 96-78 redox electrode and ORION SA-210 or 250A portable meter set to the millivolt (mV) mode.

FILLING ELECTRODE:

The electrode shall be filled with one of the two solutions selected to best match the ionic strength of the sample solution to minimize junction potentials. The following solutions shall be used:

1. Dilute solution (total ionic strength less than 0.2 molar [M]). Use ORION dilute filling solution (Cat. No. 900001), which will match the potential of a conventional calomel electrode.

2. Concentrated solution (total ionic strength greater than 0.2M). Use ORION concentrated filling solution (Cat. No. 900011), which is 4M KCl saturated with Ag/AgCl.

Filling solution level in the electrode should always be at least one inch above the level of the solution being measured.

CONNECTING THE ELECTRODE TO THE METER:

Insert the platinum redox connector (large diameter) in the pH or sensing electrode input jack on the ORION SA-210 meter and the reference electrode connector (small diameter) into the reference electrode input jack.

CALIBRATION PROCEDURE:

The meter shall be calibrated daily using a two stage process that checks the operation and accuracy of the meter. To check the operation of the meter:

1. Connect the electrodes to the meter, place the electrodes in a beaker of tap water, and turn on the meter.

2. Add a drop of dilute NaOH to the beaker and mix it with tap water.

3. If the reading on the meter decreases sharply, then the electrodes are sensitive and operating properly.

4. If little or no change in the reading is observed, then the electrodes are not functioning properly and must be cleaned. The following summarizes the electrode cleaning procedures:

   - Drain filling solution from outer portion of electrode body and refill with fresh solution (see Filling Electrode).

   - If the electrode still does not function properly, remove sleeve from the inner electrode, rinse all the parts of the electrode with DS/DI water, and allow to air dry.

   - Reassemble electrode and refill with filling solution.

To check the accuracy of the meter and EH electrode:

5. Use a standard solution consisting of Zobell's ferrous/ferric solution.

6. Rinse electrodes with DS/DI water.

7. Pour the standard solution into a small beaker and place electrodes into the beaker. The redox potential of the standard solution should read 439 +/- 30 mV. If the reading deviates from this range, then the electrodes must be cleaned (see Step 4).

MEASUREMENT PROCEDURE:

1. Set the mode switch to the mV position, and place the electrode in the sample solution. When the reading stabilizes, record the potential.

2. For some applications, redox-potential readings are reported relative to the normal hydrogen electrode (NHE). To do this, select the electrode potential (C) value in Table FM-01-1 that corresponds to the filling solution used and the temperature of the solution measured. Substitute the table value for C in the following equation and solve for E.

   $E = Eo + C$ where:

   E - Oxidation reduction potential of the sample relative to the NHE.

   Eo - Potential developed by the platinum redox electrode.

   C - Potential developed by the reference electrode relative to the NHE (see Table WFM-02-1).

TABLE WFM-02-1

POTENTIALS ("C") DEVELOPED BY THE REFERENCE ELECTRODE PORTION RELATIVE TO THE NORMAL ELECTRODE AT VARIOUS TEMPERATURES

	"C" electrode Potential in mV	
Temperature EC	900001 Solution	900011 Solution
10	251	214
20	244	204
25	241	199
30	238	194

PTS-SOP-WFM-03

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

FIELD PROCEDURES:

1. Calibrate instrument as described in instruction manual. Usually the lowest concentration standard is appropriate. Recalibrate at the end of the day and note any drift. Replace batteries and try fresh calibration solutions if meter does not calibrate properly.

2. Rinse decontaminated beaker with sample water three times.

3. Fill beaker with water sample.

4. Rinse conductivity probe with deionized water and place probe in sample water.

5. Submerge conductivity probe in sample so that flow cell holes are immersed, stir to remove any air bubbles from within flow cell. Turn instrument on to appropriate scale for sample analysis. Read specific conductance and record to the nearest one Seimen (same as micromhos/centimeter). Measure sample temperature to the nearest 0.1EC from conductivity meter after temperature has equilibrated.

6. Remove probe from sample and rinse with deionized water.

7. Correct conductivity reading to specific conductance (corrected to 25EC) by multiplying the conductivity value by the temperature correction factor and then by the probe correction factor (unless SC unit has an automatic temperature correction).

MAINTENANCE:

1. Store meter in case during transport.

2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe.

3. Inspect probe for damage or dirt.

4. If meter readings are erratic, return meter and probe to factory for repair.

PTS-SOP-WFM-04

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

NOTE: Often, temperature is measured with a pH meter or the specific conductance meter. If included as part of those instruments, use SOP for that instrument. Otherwise:

1. Provide two calibrated thermometers inside protective cases for field measurements.

2. Check thermometer for cracks or gaps in the mercury. If cracks or gaps are visible, thermometer will not be used.

3. When possible, measure temperature of surface water at midstream, submersing the thermometer for approximately one minute or until temperature stabilizes.

4. When in situ temperature measurements are not possible, draw sample of at least 200 milliliters into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about one minute).

6. Record temperature to nearest 0.5EC in field log book or on field data sheet.

7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within 0.5EC.

PTS-SOP-WFM-07

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen meter for damage. Inspect probe for sufficient electrolyte and to determine if oxygen sensor membrane is in good condition. Replace membrane if torn or wrinkled. Inspect for air bubbles beneath the membrane. If bubbles are present, remove membrane and add electrolyte solution. Replace membrane so that air bubbles are absent.

2. Rinse probe and cable with deionized water.

3. Calibrate probe and meter according to manufacturer's instructions.

4. Place probe in water body to be sampled. Raise and lower probe through water sample at a rate of about one foot per second. Allow probe sufficient time to stabilize to temperature and dissolved oxygen concentration.

5. Read and record dissolved oxygen concentration.

PTS-SOP-GW-02

STANDARD OPERATING PROCEDURE
SAMPLING WITH A BAILER FOR ORGANIC COMPOUNDS

1. If there is potential for organic vapors to be present in a well, turn on and calibrate the appropriate field monitoring instrument (e.g., PID or HNU) as directed in the instruments operation manual. Once the instrument has been calibrated, turn the instrument on, hold the instrument near the unopened well head, once the reading has stabilized record the ambient air or background value.

2. Remove the well cap and immediately insert the probe from the field monitoring instrument (e.g., PID or HNU) into the casing (head space) to measure. Lightly cover the well with the cap, taking care not to crush the instrument probe. Monitor the instrument and record the highest measurement in the field log book. Refer to the instruments operation manual and the Pioneer Technical Services Health Safety Plan for detailed information on screening well headspace if organic vapors are present.

3. Using clean, noncontaminating equipment, e.g., an electronic depth to water level indicator (avoid indicating paste), determine the water level in the well (PTS-SOP-GW-03 (Depth to Water Measurements)). If appropriate check for the presence of free or floating product with an interface probe or clear bailer (PTS-SOP-S-05, NAPL Measurements). Calculate the fluid volume in the casing and determine the appropriate purge volume required prior to sample collection.

4. Attach a clean, decontaminated bailer to clean line for lowering and raising the bailer into the well. Make sure the knot will not come loose.

5. Lower bailer slowly until it contacts water surface.

6. Allow bailer to sink slowly and fill with a minimum of surface disturbance. The bailer should not contact the bottom of the well.

7. Slowly raise bailer to surface. Do not allow bailer line to contact the ground surface.

8. Use bottom discharge device to slowly discharge purge water into an appropriate container, or pour slowly from top of bailer. Purge water shall be disposed of in accordance with the site-specific SAP and/or PTS-SOP-DE-03, Derived Wastes.

9. Repeat Steps 5 through 7 as needed to acquire sufficient purge volume.

10. If water is being collected for volatile organic compounds analysis, place preservative in vials if appropriate.

11. Once sufficient purge volume has been collected, use bottom discharge device or pour slowly from top of bailer into appropriate sample containers.

12. Repeat Steps 5 through 7 as needed to acquire sufficient sample volume.

13. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

14. Label the sample bottle with an appropriate tag/label. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.

15. Immediately place the properly labeled sample bottle in an appropriate carrying container maintained at 4°C, +/- 2°C throughout the sampling and transportation period.

16. Bailer will be thoroughly decontaminated after each use according to PTS-SOP-DE-02 (Decontamination Procedures) or disposed of per PTS-SOP-DE-03 (Derived Wastes).

PTS-SOP-GW-03

STANDARD OPERATING PROCEDURE
DEPTH TO WATER LEVEL MEASUREMENTS

Electrical Depth to Water Indicator

1) Arrive at site with proper equipment fully decontaminated and in working order.

2) Inspect well and casing for a marked measuring point. If no measuring point is marked locate the north side of the well and determine a new marking point, choose the point for ease of accurately reading the measuring tape.

3) Test that the water level indicator is on and working by pushing the test button on the indicator and checking the buzzer sound level and/or checking for the light.

4) Lower the sensor probe slowly into the well to minimized disturbance of water when it is encountered.

5) As the sensor is lowered down the well, the buzzer and/or flashing light will indicate contact with water. Be aware that sensor may indicate water prior to actual water level if the probe contacts condensation on the well casing.

6) Once the buzzer has sounded, align the marked probe cable with the designated marking point and gently raise and lower the probe until the exact mark on the probe cable when water is encountered is identified.

7) Record this information in the project logbook as the depth to water (DTW). In addition, record where the marking point was located (e.g. TOC (top of casing), TOPVC (top of PVC), IPVC (inner PVC) to help maintain continuity if subsequent DTW readings are needed from this well.

8) Reel in sensor probe.

9) Decontaminate all equipment prior to re-use.

Chalked Measuring Tape Depth to Water Measurements

1. Arrive at site with proper equipment, fully decontaminated and in working order.

2. Coat the lower three to five feet of tape with chalk and lower into well. Listen for weight to contact water and lower tape an additional 0.5 foot. Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.

3. Decontaminate all equipment before re-use.

PTS-SOP-GW-10

STANDARD OPERATING PROCEDURE
PURGING AND SAMPLING WITH A 12 VOLT SUBMERSIBLE PUMP

Sampling wells in order of increasing chemical concentrations is preferred.

1. Using clean, noncontaminating equipment, e.g., an electronic depth to water level indicator (avoid indicating paste), determine the water level in the well (PTS-SOP-GW-03, (Depth to Water Measurements)). Calculate the fluid volume in the well casing ("casing volume") and record in the logbook.

2. Attach the appropriate disposable or decontaminated tubing to the pump outlet. Teflon or Teflon lined tubing is preferred when sampling for VOCs, SVOCs, pesticides, and PCBs. PVC, polyethylene and polypropylene tubing can be used when sampling for inorganics. (Note also that all down-hole and potentially wetted surfaces must also be non-contaminating/noncontributing. This includes power and suspension cables and compressed gas or sample tubing.). The pump should also be constructed of materials compatible with the required sample analysis.

3. Lower the pre-cleaned pump and tubing gently into the well to the predetermined sampling zone. The mid-point of the saturated screen is used by convention as the location of the pump intake. Chemical concentrations or permeability considerations may require pump placement in a different zone, this will be indicated in the SAP or work plan. If possible keep the pump at least 2 feet from the bottom of the well to avoid mobilization of particulates in the bottom of the well.

4. Attach the leads of the electrical wire to a 12 volt battery which starts the pump. The tubing end should be placed in a bucket for containment prior to starting the pump. Adjust the pump speed until an appropriate discharge rate is achieved. . The pump should discharge at an extraction rate that avoids drawing down the water level below the pump intake. Measure the discharge rate using a bucket or similar container and a stop watch; record this information in the logbook If the recharge rate is slower than an attainable extraction rate using the pump and the well becomes essentially dewatered (water level falls below the intake level) the well should be allowed to recover sufficiently to fill all the appropriate sample containers, if possible do not move the pump intake during this process. Samples may then be collected even though parameters have not stabilized.

5. Collect and dispose of purged water in accordance with PTS-SOP-DE-3. Measure and record the total purge volume.

6. During well purging monitor indicator field parameters including pH, conductivity, and temperature, the SAP or work plan may indicate other field parameters that need to be

monitored such as Eh, dissolved oxygen (DO) and turbidity. Water quality parameters will be considered stable when three consecutive readings (generally 2-5 minutes apart) are as follows:

- Temperature range is no more than +/- 1 degree Celsius (°C);
- pH varies by no more than 0.1 pH units; and
- Specific conductivity readings are within 3% of the average.

Field parameters as well as depth to water level measurements should be recorded in the logbook or on field data sheets.

7. Purge a minimum of three casing volumes and/or until water quality parameters stabilize. Once these conditions occur, sampling can commence. VOC samples should be collected first and directly in to pre-preserved sample containers. Fill the sample containers by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled. Add preservative as required by analytical methods to samples immediately after collection if not collected in pre-preserved containers.

8. If a filtered sample is required an in-line high capacity (0.45 µm) should be inserted into the discharge hose after the other sample containers are filled. Fill the sample bottle and preserve immediately, cap the bottle.

9. Label the sample bottle with an appropriate tag/label. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.

10. Place the properly labeled sample bottle in an appropriate carrying container maintained at 4°C +/- 2°C throughout the sampling and transportation period.

11. The pump will be thoroughly decontaminated after each use according to PTS-SOP-DE-02, Decontamination Procedures.

Appendix C

Health and Safety Plan for Old BSB Municipal Landfill Site/Clark Tailings Facility

APPROVAL PAGE

HEALTH AND SAFETY PLAN
FOR BUTTE-SILVER BOW
OLD LANDFILL GROUNDWATER MONITORING

Prepared for:

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Reviewed by: Mitch Mihailovich, Pioneer Project Manager Date

Approved by: Dave Shultz, BSB Director of Public Works

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Appendix A Hospital Information

1 INTRODUCTION

The purpose of this Health and Safety Plan (HASP) is to set forth the minimum acceptable requirements and procedures for all the groundwater sampling activities conducted at the Old Butte-Silver Bow Landfill/Clark Tailings (Old Landfill). All work practices and procedures are designed to minimize exposure to hazardous materials and to eliminate any possibility of physical injury to Pioneer Technical Services, Inc. (Pioneer) employees, Montana Department of Environmental Quality (DEQ) personnel, subcontractors, and the local communities. Work performed under this HASP will be in accordance with applicable State of Montana Regulations, Occupational Safety and Health Administration (OSHA) Regulations, U.S. Environmental Protection Agency (EPA), and any other applicable standards and/or regulations.

2 ASSIGNMENT OF RESPONSIBILITIES

The members associated with the field sampling are listed below with their titles and responsibilities.

- DEQ Project Officer –;John Collins
- Site Project Manager –;Mitch Mihailovich
- Health and Safety Officer –Tara Schleeman; and
- Field Team Members – DJ Renz, Thomas Hickey and Brad Hollamon.

Field Team Members conduct the field activities with the Site Project Manager and the Health and Safety Officer including sampling, monitoring, and decontamination procedures.

3 BACKGROUND

3.1.1 Site Description

The Old Landfill is located approximately 1 mile southwest of the city of Butte and covers approximately 130 acres. The site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County. The Old Landfill is accessed by traveling west to Butte, Montana, on U.S. Interstate 90 (I-90) and exiting at exit ramp 126, and then turning south on Montana Street. After traveling approximately 0.65 miles on Montana Street, a turn is made to the southwest onto Beef Trail Road, which is followed for approximately 0.5 miles where a turn is made to the east into the Copper Mountain Sports and Recreation Complex, which overlies the Old Landfill. The Copper Mountain Sports and Recreation Complex is composed of baseball diamonds, a walking trail, football/soccer fields, a children's playground, sand volleyball courts, and a driving range.

3.2 Site History

The Old Landfill opened in approximately 1968 and accepted municipal solid waste from Butte and its vicinity and was issued an operating license by the DEQ in 1978 (a permit was not required previously). The Old Landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). It is estimated that approximately 600,000 tons of refuse had been disposed of at the site (Pioneer, 1997). During November 1990, the DEQ conducted a Preliminary Assessment (PA) of the Landfill in accordance with the National Contingency Plan (NCP). The site did not score high enough to be included as a Superfund site. In July 1992, Butte-Silver Bow was notified by DEQ that a Groundwater Monitoring Plan and a Groundwater Sampling and Analysis Plan (SAP) were required at the Landfill. Wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Assessment monitoring results showed that groundwater protection standards (GWPS) were exceeded for certain volatile organic compounds (VOCs) and thallium. Groundwater monitoring has been conducted biannually since that time. Landfill capping and passive gas venting as a corrective measure was approved on March 21, 1997. Remedial construction began in 1997 and was completed in 1998.

The Clark Tailings consisted of a 60-acre impoundment with approximately 1,000,000 cubic yards (cy) of mill tailings (Hydrometrics, 1983) immediately adjacent to and partially mixed with the Landfill. The mixed nature of the wastes necessitated a combined Superfund and the Resource Conservation and Recovery Act (RCRA) response action be performed under RCRA jurisdiction.

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During its years of operation, the mill served primarily as a zinc and copper concentrator. The Clark Tailings were reclaimed in the mid-1980s as part of the "Clark Tailings Erosion Control Project," by the Anaconda Minerals Company; however, vegetation recovery was sparse in many areas and it was determined that additional reclamation was necessary. During reclamation of the Colorado Tailings in the Lower Area One Operable Unit in the Butte Silver-Bow Superfund Site, approximately 800,000 cy of tailings were placed in a repository constructed at the Clark Tailings.

The final RCRA repository cover for the Old Landfill was designed in 1997 and constructed in 1997 and 1998. The Copper Mountain Sports and Recreational Complex was included as part of the final design and today the reclaimed area has several irrigated baseball and football fields, a walking trail, a children's playground and sand volleyball courts.

4 PROJECT DESCRIPTION

The groundwater sampling is limited to the sampling of six wells, three groundwater monitoring wells currently located within the Old Landfill (BSB-A1, BSB-A5 and BSB-A6R), one monitoring well located on Butte-Silver Bow land just west of the Old Landfill (MBMG-2), a monitoring well located on the northwest corner of the Old Landfill and in the right-of-way of Little Basin Creek Road (CLK-2), and one monitoring well located on private property east of the Old Landfill boundaries (CLK-1). Static water levels will be measured in each of these wells on a semi-annual basis, in approximately March and September to document depth-to-groundwater and groundwater flow direction. Additionally, groundwater samples will be collected from the six wells on a semi-annual basis.

5 HEALTH AND SAFETY

While conducting sampling, personnel may be exposed to both chemical and physical hazards. Chemical hazards include exposure to groundwater with elevated vinyl chloride, arsenic, antimony, cadmium, nickel, and zinc concentrations. Additional chemical hazards include sample preservation acids (nitric and hydrochloric acid). Physical hazards include temperature extremes. Other hazards that may be present on site include lightning, insects, and slips, trips and falls. The site hazards are discussed in the following sections.

5.1 Chemical Hazards

The following subsections provide information on the chemical compounds found in the groundwater.

5.1.1 Vinyl Chloride

Vinyl chloride is a colorless, flammable gas at normal temperatures with a mild, sweet odor. It is a manufactured substance that is used to make polyvinyl chloride (PVC) and is used to make a variety of plastic products, including pipes, wire and cable coatings, and furniture upholstery. Vinyl chloride also results from the breakdown of other substances, such as trichloroethane, trichloroethylene, and tetrachlorothylene (ASTDR ToxFAQs).

Vinyl chloride can enter the body through inhalation of contaminated air, ingestion of contaminated food/water, or adsorption through skin/eye contact.

Skin contact with the chemical will cause numbness, redness, and blisters. Long-term exposure may cause nerve damage and immune reactions.

The Department of Human Health Services (DHHS) has determined that vinyl chloride is a known human carcinogen. Vinyl chloride exposure can result in liver cancer in people.

The OSHA Permissible Exposure Limit (PEL) for vinyl chloride is 1 parts per million (ppm).

5.1.2 Antimony

Routes of entry for antimony include inhalation, ingestion, and skin absorption. Signs and symptoms of exposure include cough, vomiting, dry skin, abdominal pain, vomiting, and diarrhea. Short-term exposure effects include gastrointestinal irritation and short-term exposure to levels far above the Occupational Exposure Limit (OEL) could result in death. Long-term exposure to the skin may cause dermatitis, especially when exposed to fumes. This substance may have effects on the eye, respiratory tract and lungs, resulting in pneumoconiosis.

The OEL for antimony is a PEL and Threshold Limit Value (TLV) of 0.5 milligrams per square meter (mg/m^3).

5.1.3 Arsenic

Arsenic is a silver-gray or tin-white metal that is found in the earth's crust. Routes of entry include inhalation, ingestion, skin, and/or eye contact absorption. Symptoms of exposure include discoloration of the skin and appearance of small corns or warts, gastrointestinal disturbances, and respiratory irritation.

The OSHA PEL is a Time Weighted Average (TWA) of 0.010 mg/m^3.

5.1.4 Cadmium

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). All soils and rocks, including coal, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Routes of entry for cadmium are inhalation, skin absorption, skin or eye contact and ingestion. Signs and symptoms of exposure are gastronomic distress, vomiting, diarrhea, respiratory irritation, and hyperpigmentation of skin. Cadmium is a potential occupational carcinogen. Long-term exposure can cause lung damage and fragile bones.

The OSHA PEL is a TWA of 0.005 mg/m^3.

5.1.5 Nickel

Routes of exposure include inhalation, ingestion, and skin contact. The most common adverse health effect of nickel is an allergic reaction. People can become sensitive to nickel when jewelry or other things containing nickel are in direct contact with the skin. Once a person is sensitized to nickel, further contact with the metal will produce a reaction. Usually a skin rash develops at the site of contact. In some cases, dermatitis may develop at a site away from the site of contact. Some people who are sensitized have asthma attacks following exposure to nickel

People who are not sensitive to nickel must eat very large amounts of nickel to suffer adverse health effects. The most serious effects of nickel, such as cancer of the lung and nasal sinus, have occurred in people who have breathed dust containing nickel compounds while working in

refineries or processing plants. Other lung effects including chronic bronchitis and reduced lung function have been observed in workers breathing nickel.

The OEL for nickel is PEL and TLV of 1 mg/m^3.

5.1.6 Zinc

Routes of entry for zinc include inhalation, ingestion, and skin contact. Signs and symptoms of exposure include metallic taste, metal fume fever, dry skin, abdominal pain, nausea, and vomiting.

Short-term exposure to zinc fumes may cause metal fume fever and the effects may be delayed. Long-term skin contact may cause dermatitis.

The OELs for this substance are an OSHA PEL of 15 mg/m^3 and an American Conference of Governmental Industrial Hygienist (ACGIH) TLV of 10 mg/m^3.

5.2 Physical Hazards

The physical hazards associated with this project include heat and cold stresses.

5.2.1 Cold Temperature Emergencies

Other physical hazards include temperature extremes. The potential for cold emergencies to personnel will be mild to significant based on the personal protective equipment (PPE) being worn, the ambient temperature, and the amount of activity. The health effects associated with cold stress are frostbite, trench foot, and general hypothermia.

Frostbite happens when the skin tissue actually freezes and cell damage results. Fingers, toes, cheeks, nose, and ears are commonly affected. The symptoms of frostbite include an uncomfortable sensation of coldness; there may be a tingling, stinging, or aching feeling followed by numbness. Initially the frostbitten area appears white and cold to the touch. This is followed by heat, redness, and swelling. Tissue damage can be mild or severe resulting in scarring and tissue death. First aid includes treating affected areas with warm water. Do not rub the affected areas.

Trench foot may be caused by continuous exposure to a wet and cold environment or immersion in water. Symptoms include a tingling and/or itching sensation, pain, and swelling. Blisters may form and be followed by death of skin tissue and ulceration. Treatment includes moving the victim to a warm area and treating the affected part with warm water or warm packs. Medical attention should be obtained as soon as possible.

General hypothermia is progressive loss of body heat with prolonged exposure to cold. Signs and symptoms of exposure include uncontrollable shivering and feeling cold. As the body temperature continues to drop, a person may become confused, careless, and disoriented. If the core body temperature falls below 86 degrees Fahrenheit (° F), the body's adaptive mechanisms for reducing heat loss become ineffective and death can occur. First aid includes moving the

individual to a warm, dry shelter. All wet clothing should be removed and the individual should be wrapped in warm blankets. Warm, non-alcoholic, caffeine-free drinks may be given.

5.2.2 Warm Temperature Emergencies

Personnel need to be aware of the signs and symptoms of heat stress. Heat stress occurs when the body is unable to cool itself. Continued exposure to heat can cause heat cramps, heat exhaustion, and heat stroke.

Heat cramps are painful spasms of the muscles. They are caused when workers fail to replace their bodies' salt loss. Heat cramps may occur during or after work and may be relieved by taking liquids by mouth or saline solutions intravenously for quicker relief, if medically required.

Heat exhaustion results from loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt, or both. The signs and symptoms of heat exhaustion include extreme weakness or fatigue, giddiness, nausea, headache, clammy and moist skin, pale or flushed complexion, and slightly higher body temperature. First aid includes resting in a cool place and drinking an electrolyte solution.

Heat stroke is the most serious form of heat stress. It is caused by the failure of the body's internal mechanism to regulate its core temperature. The body cannot cool itself and sweating stops. Signs and symptoms include mental confusion, delirium, and loss of consciousness, convulsions or coma, body temperature of 106 ° F or higher and dry hot skin. The victim must be moved to a cool area and his/her clothing soaked with cool water. Medical treatment is necessary.

5.3 Other Hazards

5.3.1 Lightning

Go to a safe shelter immediately. This includes a building or a hard top car with the window up. If in wooded area, seek shelter under thick growths of relatively small trees. Avoid isolated trees or other tall objects, bodies of water, sheds, fences, and heavy equipment.

5.3.2 Insect Bites/Stings

Symptoms may include redness, rash, swelling, chills, fever, diarrhea, and vomiting. Seek medical assistance. Wear protective outer clothing, such as long-sleeved shirts and gloves to prevent a bite or sting.

5.3.3 Slips, Trips, and Falls

Employees will be required to work on uneven terrain. Boots with traction will be worn. Always watch were you are stepping and be aware of the surroundings.

5.4 New or Additional Hazards

New and/or additional hazards will be discussed during the daily health and safety meeting. The hazards and appropriate control measures will be recorded in the logbook.

5.5 Personal Protective Equipment Requirements

All personnel involved with the field operations will use Level D PPE, which includes coveralls and safety boots. Other Level D equipment may be used as appropriate, including: hardhat, gloves, or safety glasses. The PPE will be upgraded if conditions change.

5.6 Initial Health and Safety Training

All personnel associated with sampling activities must have completed the 40-hour initial training per 29 Code of Federal Regulations (CFR), Part 1910.120 (e)(1) and the subsequent 8-hour annual refresher training, if applicable. At least one team member will have current American Red Cross community first aid and Cardiopulmonary Resuscitation (CPR) training. Proof of certification is required on-site.

5.7 Visitors

Visitors must report to the Site Project Manager who will record the visitor in the field logbook. Visitors must demonstrate compliance with the training requirements to enter the exclusion zone (area of drilling and/or sampling). Visitors who are not exposed to sampling materials are not considered at risk; therefore, they are considered exempt from the above training requirements. Visitors will be allowed access to the exclusion zone areas if they demonstrate compliance with 29 CRF Part 1910.120 (e).

5.8 Review of Health and Safety Plan

All personnel will review the HASP prior to the start of work and are expected to work in accordance with the HASP. The Site Project Manager/Safety Manager will be notified of any situation presenting a risk that has not been addressed in the plan.

5.9 Health and Safety Meetings

The Health and Safety meeting will be conducted each day, prior to starting work, to cover the suspected hazards expected for that day's work and the precautions necessary to deal with the hazards. If any unusual situation arises that might present an unsafe condition that was not discussed in the Health and Safety meeting, the Site Project Manager will stop work until an assessment of the problem has been made.

5.10 Emergency Procedures

In the case of an emergency, all workers will be evacuated from the site. The Health and Safety Officer is expected to notify the field team members of the closest hospital (Appendix A) and the appropriate route to the hospital (Appendix A – Figure 1). Emergency medical personnel, fire suppression, and law enforcement are available to the site by dialing 911 at the nearest phone (Pioneer personnel will have a cellular phone on-site).

5.11 Personal/Equipment Decontamination

The following details decontamination of on-site personnel and equipment:

- All equipment will be decontaminated prior to use and prior to leaving the site. Decontamination consists of a tap water rinse, a soap and tap water wash, a distilled water rinse, and a methanol rinse.
- Decontamination fluids will be disposed to the ground surface leaving any site hazardous material on-site.
- Personnel will wash hands prior to drinking or eating.
- Eating and drinking areas will be separated from the sampling area and determined by the Health and Safety Officer.

5.12 General Health and Safety Rules

The following are general health and safety rules that will be enforced:

- A standard first aid kit will be present on-site at all times;
- Sampling will always take place with a minimum of two people on a team; and
- Sampling will only take place during the daylight hours.

6 REFERENCES

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Smith, R., 1953. *History of Early Reduction Plants of Butte, Montana*, reprint from De Re Metallica, Vol. 18, Nos. 2 and 3.

Pioneer, 1997. *Final Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment*. January 1997.

APPENDIX A

HOSPITAL INFORMATION

HOSPITAL INFORMATION
BSB Old Landfill Site

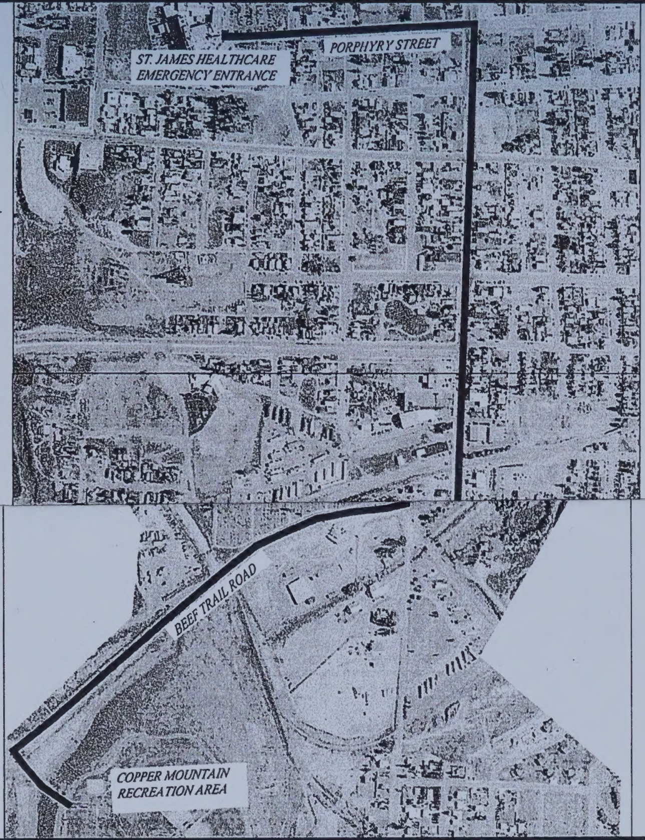
The nearest hospital location is: Butte, Montana (map on next page)

St. James Healthcare
400 S. Clark
Butte, Montana
(406) 723-2500

The ambulance, fire department, and sheriff can be reached by dialing 911.

Poison Control Center: 1-800-525-5042

Pioneer staff will carry a cellular phone with them on-site.


ST. JAMES HEALTHCARE
EMERGENCY ENTRANCE
PORPHYRY STREET
BEEF TRAIL ROAD
COPPER MOUNTAIN
RECREATION AREA

PROJECTION: ______________________

ZONE: ______________________

DATUM: ______________________

UNITS: ______________________

SOURCE: ______________________

SCALE IN FEET

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FIGURE 1 EMERGENCY ROUTE COPPER MNT TO ST JAMES

PIONEER
TECHNICAL SERVICES, INC.

Butte, Helena, Anaconda

DATE: 3/10/2009

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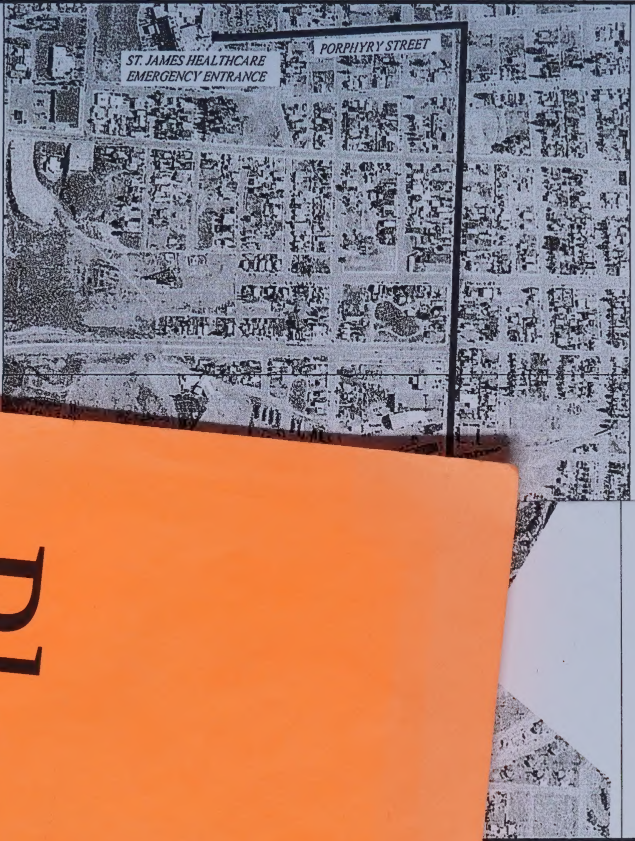
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EMERGENCY ENTRANCE
PORPHYRY STREET

GURE 1 EMERGENCY ROUTE
COPPER MNT TO ST JAMES

PIONEER
TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 3/10/2009

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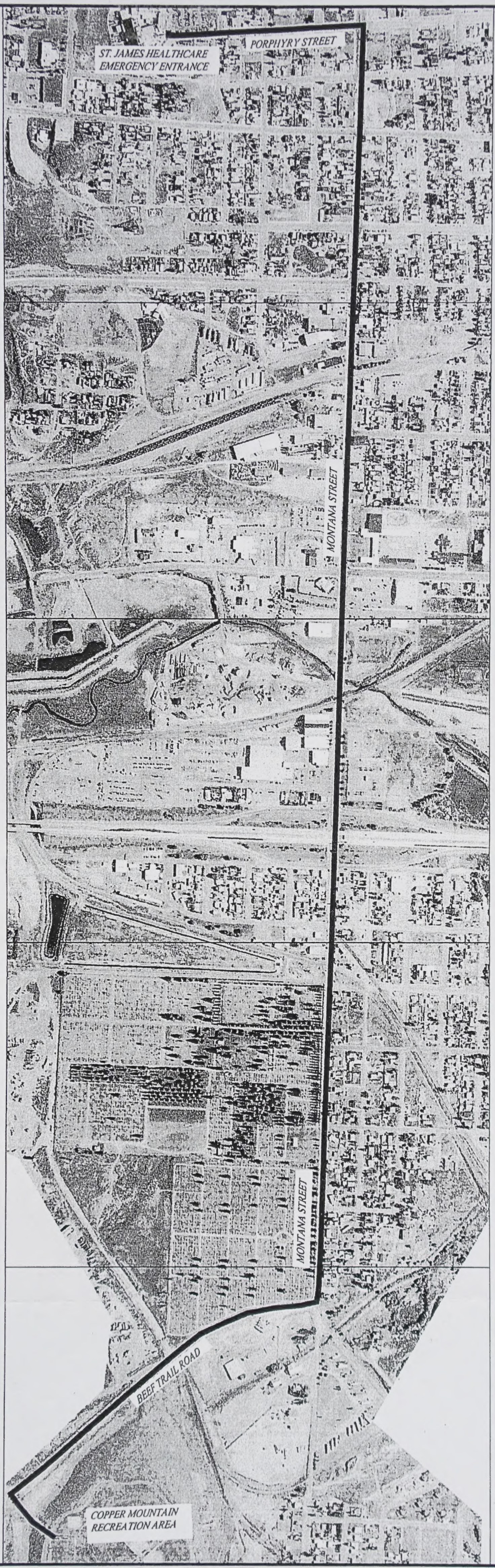
ST. JAMES HEALTHCARE
EMERGENCY ENTRANCE
PORPHYRY STREET
MONTANA STREET
MONTANA STREET
BEEF TRAIL ROAD
COPPER MOUNTAIN
RECREATION AREA
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PROJECTION:
ZONE:
DATUM:
UNITS:
SOURCE:

SCALE IN FEET
0

FIGURE 1 EMERGENCY ROUTE
COPPER MNT TO ST JAMES

PIONEER
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DATE: 3/10/2009

FILE PATH

Appendix D

Pace Laboratories QA/QC Programs

QUALITY ASSURANCE MANUAL

Quality Assurance/Quality Control Policies and Procedures

Pace Analytical Services – Minneapolis
1700 Elm Street SE, Suite 200, Minneapolis, MN 55414
612-607-1700

Pace Analytical Services, Inc. – Montana
150 North 9th Street, Billings, Montana 59101
406-254-7226

Pace Analytical Services, Inc. – Virginia and Duluth
315 Chestnut Street, Virginia, MN 55792
206 2nd Avenue West, Virginia, MN 55792
1510 W Superior Street, Duluth, 55806
218-735-6700

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Any printed documents in use within a Pace Analytical Services, Inc. laboratory have been reviewed and approved by the persons listed on the cover page. They can only be deemed official if proper signatures are present.

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1.0. INTRODUCTION AND ORGANIZATIONAL STRUCTURE

"Working together to protect our environment and improve our health"
Pace Analytical Services Inc. - Mission Statement

1.1. Introduction to PASI

1.1.1. Pace Analytical Services, Inc. (PASI) is a privately held, full-service analytical testing firm operating a nationwide system of laboratories. PASI offers extensive services beyond standard analytical testing, including: bioassay for aquatic toxicity, air toxics, dioxins and coplanar PCB's by high resolution mass spectroscopy , radiochemical analyses, product testing, pharmaceutical testing, field services and mobile laboratory capabilities. PASI has implemented a consistent Quality System in each of its laboratories and service centers. In addition, the company utilizes an advanced data management system that is highly efficient and allows for flexible data reporting. Together, these systems ensure data reliability and superior on-time performance. This document defines the Quality System and QA/QC protocols.

1.1.2. Our goal is to combine our expertise in laboratory operations with customized solutions to meet the specific needs of our customers.

1.2. Statement of Purpose

1.2.1. To meet the business needs of our customers for high quality, cost-effective analytical measurements and services.

1.3. Quality Policy Statement and Goals of the Quality System

1.3.1. PASI management is committed to maintaining the highest possible standard of service for our customers by following a documented quality system that is fully compliant with the applicable NELAC or TNI standards. The overall objective of this quality system is to provide reliable data of known quality through adherence to rigorous quality assurance policies and quality control procedures as documented in this Quality Assurance Manual.

1.3.2. All personnel within the PASI network are required to be familiar with all facets of the quality system relevant to their position and implement these policies and procedures in their daily work. This daily focus on quality is applied with initial project planning, continued through all field and laboratory activities, and is ultimately included in the final report generation.

1.3.3. PASI management demonstrates its commitment to quality by providing the resources, including facilities, equipment, and personnel to ensure the adherence to these documented policies and procedures and to promote the continuous improvement of the quality system. All PASI personnel must comply with all current applicable state, federal, and industry standards (2003 NELAC Standard, 2009 TNI Standard, etc.), and are required to perform all tests in accordance with stated methods and customer requirements.

1.4. Core Values

1.4.1. **Integrity**- Pace personnel are required to abide by the PASI Code of Ethics and all Pace employees must go through Data Integrity/Ethics training upon initial orientation and as an annual refresher.

1.4.2. **Value Employees**- Pace management views employees as our most important asset and communicates to them the relevance and importance of their activities within their job functions and how they contribute to the achievement of the objectives of the quality management system.

1.4.3. **Know Our Customers**- Pace makes every effort to know our customers and address their sampling and analytical needs. More information on this item can be found in section 2.0.

1.4.4. **Honor Commitments**- Pace labs focus on making solid commitments with regards to quality, capacity, and agreed upon turnaround time to our customers.

1.4.5. **Flexible Response To Demand**- Pace labs are equipped with both the material and personnel resources to enable them to be responsive to the demands of customers when situations or projects need change.

1.4.6. **Pursue Opportunities**- Pace is committed to pursuing opportunities for the growth of the company by constantly exploring markets and areas where we can expand.

1.4.7. **Continuously Improve**- Pace has committed much time and effort into establishing a continuous improvement program where company personnel meet on a regular basis to share ideas in cost reduction, production improvement and standardization in order to develop best practices. This information, as well as company financial and production metrics, are tracked, evaluated, and shared with each Pace facility.

1.5. Code of Ethics

1.5.1. PASI's fundamental ethical principles are as follows:

1.5.1.1. Each PASI employee is responsible for the propriety and consequences of his or her actions;

1.5.1.2. Each PASI employee must conduct all aspects of Company business in an ethical and strictly legal manner, and must obey the laws of the United States and of all localities, states and nations where PASI does business or seeks to do business;

1.5.1.3. Each PASI employee must reflect the highest standards of honesty, integrity and fairness on behalf of the Company with customers, suppliers, the public, and one another.

1.5.1.4. Each PASI employee must recognize and understand that our daily activities in environmental laboratories affect public health as well as the environment and that environmental laboratory analysts are a critical part of the system society depends upon to improve and guard our natural resources:

1.5.2. Strict adherence by each PASI employee to this Code of Ethics and to the Standards of Conduct is essential to the continued vitality of PASI and to continue the pursuit of our common mission to protect our environment and improve our health.

1.5.3. Failure to comply with the Code of Ethics and Standards of Conduct will result in disciplinary action up to and including termination and referral for civil or criminal prosecution

where appropriate. An employee will be notified of an infraction and given an opportunity to explain, as prescribed under current disciplinary procedures.

1.5.4. Any Pace employee can contact corporate management to report an ethical concern by calling the anonymous hotline at 612-607-6431.

1.6. Standards of Conduct

1.6.1. Data Integrity

1.6.1.1. The accuracy and integrity of the analytical results and its supporting documentation produced at PASI are the cornerstones of the company. Lack of data integrity is an assault on our most basic values putting PASI and its employees at grave financial and legal risk and will not be tolerated. Therefore, employees are to accurately prepare and maintain all technical records, scientific notebooks, calculations, and databases. Employees are prohibited from making false entries or misrepresentations of data for any reason.

1.6.1.2. Managerial staff must make every effort to ensure that personnel are free from any undue pressures that may affect the quality or integrity of their work including commercial, financial, over-scheduling, and working condition pressures.

1.6.2. Confidentiality

1.6.2.1. PASI employees must not use or disclose confidential or proprietary information except when in connection with their duties at PASI. This is effective over the course of employment and for an additional period of two years thereafter.

1.6.2.2. Confidential or proprietary information, belonging to either PASI and/or its customers, includes but is not limited to test results, trade secrets, research and development matters, procedures, methods, processes and standards, company-specific techniques and equipment, marketing and customer information, inventions, materials composition, etc.

1.6.3. Conflict of Interest

1.6.3.1. PASI employees must avoid situations that might involve a conflict of interest or could appear questionable to others. The employee must be careful in two general areas:

1.6.3.1.1. Participation in activities that conflict or appear to conflict with the employees' PASI responsibilities.

1.6.3.1.2. Offering or accepting anything that might influence the recipient or cause another person to believe that the recipient may be influenced to behave or in a different manner than he would normally. This includes bribes, gifts, kickbacks, or illegal payments.

1.6.3.2. Employees are not to engage in outside business or economic activity relating to a sale or purchase by the Company. Other problematic activities include service on the Board of Directors of a competing or supplier company, significant ownership in a competing or supplier company, employment for a competing or supplier company, or participation in any outside business during the employee's work hours.

1.6.4. Compliance

1.6.4.1. All employees are required to read, understand, and comply with the various components of the standards listed in this document. As confirmation that they understand their responsibility, each employee is required to sign an acknowledgment form annually that then becomes part of the

employee's permanent record. Employees will be held accountable for complying with the Quality Systems as summarized in the Quality Assurance Manual.

1.7. Laboratory Organization

1.7.1. The PASI Corporate Office centralizes company-wide accounting, business development, financial management, human resources development, information systems, marketing, quality, safety, and training activities. PASI's Director of Quality is responsible for assisting the development, implementation and monitoring of quality programs for the company. See Attachment IIB for the Corporate Organizational structure.

1.7.2. Each laboratory within the system operates with local management, but all labs share common systems and receive support from the Corporate Office.

1.7.3. A Senior General Manager (SGM) oversees all laboratories and service centers in their assigned region. Each laboratory or facility in the company is then directly managed by an SGM, a General Manager (GM), an Assistant General Manager (AGM), or an Operations Manager (OM). Quality Managers (QM) or Senior Quality Managers (SQM) at each laboratory report directly to the highest level of local laboratory management, however named, that routinely makes day-to-day decisions regarding that facility's operations. The QMs and SQMs will also receive guidance and direction from the corporate Director of Quality.

1.7.4. The SGM, GM, AGM or OM, or equivalent functionality in each facility, bears the responsibility for the laboratory operations and serves as the final, local authority in all matters. In the absence of these managers, the SQM/QM serves as the next in command, unless the manager in charge has assigned another designee. He or she assumes the responsibilities of the manager, however named, until the manager is available to resume the duties of their position. In the absence of both the manager and the SQM/QM, management responsibility of the laboratory is passed to the Technical Director, provided such a position is identified, and then to the most senior department manager until the return of the lab manager or SQM/QM. The most senior department manager in charge may include the Client Services Manager or the Administrative Business Manager at the discretion of the SGM/GM/AGM/OM.

1.7.5. A Technical Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full-time staff member meeting the qualifications of the technical director to temporarily perform this function. The laboratory SGM/GM/AGM/OM or SQM/QM has the authority to make this designation in the event the existing Technical Director is unable to do so. If this absence exceeds 35 consecutive calendar days, the primary accrediting authority shall be notified in writing.

1.7.6. The SQM/QM has the responsibility and authority to ensure the Quality System is implemented and followed at all times. In circumstances where a laboratory is not meeting the established level of quality or following the policies set forth in this Quality Assurance Manual, the SQM/QM has the authority to halt laboratory operations should he or she deem such an action necessary. The SQM/QM will immediately communicate the halting of operations to the SGM/GM/AGM/OM and keep them posted on the progress of corrective actions. In the event the SGM/GM/AGM/OM and the SQM/QM are not in agreement as to the need for the suspension, the Chief Operating Officer and Director of Quality will be called in to mediate the situation.

1.7.7. The technical staff of the laboratory is generally organized into the following functional groups:

- Organic Sample Preparation

- Wet Chemistry Analysis
- Metals Analysis
- Volatiles Analysis
- Semi-volatiles Analysis
- HRMS Analysis
- Radiochemical Analysis
- Microbiology

1.7.8. Appropriate support groups are present in each laboratory. The actual organizational structure for PASI – Minneapolis, Billing, Virginia and Duluth are listed in Attachment II. In the event of a change in SGM/GM/AGM/OM, SQM/QM, or any Technical Director, the laboratory will notify its accrediting authorities and revise the organizational chart in the Quality Assurance Manual (QAM) within 30 days. For changes in Department Managers or Supervisors or other laboratory personnel, no notifications will be sent to the laboratory's accrediting agencies; changes to the organizational chart will be updated during or prior to the annual review process. Changes or additions in these key personnel will also be noted by additional signatures on the QAM, as applicable. In any case, the QAM will remain in effect until the next scheduled revision.

1.8. Laboratory Job Descriptions

1.8.1. Senior General Manager

- Oversees all functions of all the operations within their designated region;
- Oversees the development of local GMs/AGMs/OMs within their designated region;
- Oversees and authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Oversees the preparation of budgets and staffing plans for all operations within their designated region;
- Ensures compliance with all applicable state, federal and industry standards;
- Works closely with Regional Sales Management.

1.8.2. General Manager

- Oversees all functions of their assigned operations;
- Authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Prepares budgets and staffing plans;
- Monitors the Quality Systems of the laboratory and advises the SQM/QM accordingly;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.3. Assistant General Manager / Operations Manager

- In the absence of the SGM/GM, performs all duties as listed above for the SGM or GM;
- Oversees the daily production and quality activities of all departments;
- Manages all departments and works with staff to ensure department objectives are met;
- Works with all departments to ensure capacity and customer expectations are accurately understood and met;
- Works with SGM/GM to prepare appropriate budget and staffing plans for all departments;

- Responsible for prioritizing personnel and production activities within all departments;
- Performs formal and informal performance reviews of departmental staff.

1.8.4. Senior Quality Manager

- Provides quality oversight for multiple laboratories where there is not a local quality manager or for labs where there are multiple and separately distinct quality systems in the same facility;
- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Quality;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;
- Monitors Quality Assurance/Quality Control activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Quality office). The Quality Manager is responsible for reporting the lab's level of compliance to these standards to the Corporate Director of Quality on a quarterly basis;
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS), and evaluates the effectiveness of training;
- Monitors correctives actions;
- Maintains the currency of the Quality Manual.

1.8.5. Quality Manager

- Responsible for implementing, maintaining and improving the quality system while functioning independently from laboratory operations. Reports directly to the highest level of local laboratory facility management, however named, that routinely makes day-to-day decisions regarding laboratory operations, but receives direction and assistance from the Corporate Director of Quality. They may also report to a Senior Quality Manager within the same facility;
- Ensures that communication takes place at all levels within the lab regarding the effectiveness of the quality system and that all personnel understand their contributions to the quality system;
- Monitors Quality Assurance/Quality Control activities to ensure that the laboratory achieves established standards of quality (as set forth by the Corporate Quality office). The Quality Manager is responsible for reporting the lab's level of compliance to these standards to the Corporate Director of Quality on a quarterly basis;
- Maintains records of quality control data and evaluates data quality;

- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS), and evaluates the effectiveness of training;
- Monitors correctives actions;
- Maintains the currency of the Quality Manual.

1.8.6. Quality Analyst

- Assists the SQM/QM in the performance of quality department responsibilities as delegated by the SQM/QM;
- Assists in monitoring QA/QC data;
- Assists in internal audits;
- Assists in maintaining training records;
- Assists in maintaining the document control system;

1.8.7. Technical Director

- Monitors the standards of performance in quality assurance and quality control data;
- Monitors the validity of analyses performed and data generated;
- Reviews tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Serves as the manager of the laboratory in the absence of the SGM/GM/AGM/OM and SQM/QM;
- Provides technical guidance in the review, development, and validation of new methodologies.

1.8.8. Administrative Business Manager

- Responsible for financial and administrative management for the entire facility;
- Provides input relative to tactical and strategic planning activities;
- Organizes financial information so that the facility is run as a fiscally responsible business;
- Works with staff to confirm that appropriate processes are put in place to track revenues and expenses;
- Provide ongoing financial information to the SGM/GM/AGM/OM and the management team so they can better manage their business;
- Utilizes historical information and trends to accurately forecast future financial positions;
- Works with management to ensure that key measurements are put in place to be utilized for trend analysis—this will include personnel and supply expenses, and key revenue and expense ratios;

- Works with SGM/GM/AGM/OM to develop accurate budget and track on an ongoing basis;
- Works with entire management team to submit complete and justified capital budget requests and to balance requests across departments;
- Works with project management team and administrative support staff to ensure timely and accurate invoicing.

1.8.9. Client Services Manager

- Oversees all the day to day activities of the Client Services Department which includes Project Management and, possibly, Sample Control;
- Responsible for staffing and all personnel management related issues for Client Services;
- Serves as the primary senior consultant to customers on all project related issues such as set up, initiation, execution and closure;
- Performs or is capable of performing all duties listed for that of Project Manager.

1.8.10. Project Manager

- Coordinates daily activities including taking orders, reporting data and analytical results;
- Serves as the primary technical and administrative liaison between customers and PASI;
- Communicates with operations staff to update and set project priorities;
- Provides results to customers in the requested format (verbal, hardcopy, electronic, etc.);
- Works with customers, laboratory staff, and other appropriate PASI staff to develop project statements of work or resolve problems of data quality;
- Responsible for solicitation of work requests, assisting with proposal preparation and project initiation with customers and maintain customer records;
- Mediation of project schedules and scope of work through communication with internal resources and management;
- Responsible for preparing routine and non-routine quotations, reports and technical papers;
- Interfaces between customers and management personnel to achieve customer satisfaction;
- Manages large-scale complex projects;
- Supervises less experienced project managers and provide guidance on management of complex projects;
- Arranges bottle orders and shipment of sample kits to customers;
- Verifies login information relative to project requirements and field sample Chains-of-Custody.

1.8.11. Project Coordinator

- Responsible for preparation of project specifications and provides technical/project support;
- Coordinates project needs with other department sections and assists with proposal preparation;
- Prepares routine proposals and invoicing;
- Responsible for scanning, copying, assembling and binding final reports;
- Other duties include filing, maintaining forms, process outgoing mail, maintaining training database and data entry.

1.8.12. Department Manager/Supervisor

- Oversees the day-to-day production and quality activities of their assigned department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied;
- Assesses data quality and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.13. Group Supervisor/Leader

- Trains analysts in laboratory operations and analytical procedures;
- Organizes and schedules analyses with consideration for sample holding times;
- Implements data verification procedures by assigning data verification duties to appropriate personnel;
- Evaluates instrument performance and supervises instrument calibration and preventive maintenance programs;
- Reports non-compliance situations to laboratory management including the SQM/QM.

1.8.14. Laboratory Analyst

- Performs detailed preparation and analysis of samples according to published methods and laboratory procedures;
- Processes and evaluates raw data obtained from preparation and analysis steps;
- Generates final results from raw data, performing primary review against method criteria;
- Monitors quality control data associated with analysis and preparation. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks;
- Reports data in LIMS, authorizing for release pending secondary approval;
- Conducts routine and non-routine maintenance of equipment as required;
- Performs or is capable of performing all duties associated with that of Laboratory Technician.

1.8.15. Laboratory Technician

- Prepares standards and reagents according to published methods or in house procedures;
- Performs preparation and analytical steps for basic laboratory methods;
- Works under the direction of a Laboratory Analyst on complex methodologies;
- Assists Laboratory Analysts on preparation, analytical or data reduction steps for complex methodologies;
- Monitors quality control data as required or directed. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks.

1.8.16. Sample Management Personnel

- Signs for incoming samples and verifies the data entered on the Chain of custody forms;
- Enters the sample information into the Laboratory Information Management System (LIMS) for tracking and reporting;

- Stages samples according to EPA requirements;
- Assists Project Managers and Coordinators in filling bottle orders and sample shipments.

1.8.17. Systems Administrator or Systems Manager

- Assists with the creation and maintenance of electronic data deliverables (EDDs);
- Coordinates the installation and use of all hardware, software and operating systems;
- Performs troubleshooting on all aforementioned systems;
- Trains new and existing users on systems and system upgrades;
- Maintains all system security passwords;
- Maintains the electronic backups of all computer systems.

1.8.18. Safety/Chemical Hygiene Officer

- Maintains the laboratory Chemical Hygiene Plan;
- Plans and implements safety policies and procedures;
- Maintains safety records;
- Organizes and/or performs safety training;
- Performs safety inspections and provides corrective/preventative actions;
- Assists personnel with safety issues.

1.8.19. Program Director/Hazardous Waste Coordinator (or otherwise named)

- Evaluates waste streams and helps to select appropriate waste transportation and disposal companies;
- Maintains complete records of waste disposal including waste manifests and state reports;
- Assists in training personnel on waste-related issues such as waste handling and storage, waste container labeling, proper satellite accumulation, secondary containment, etc.;
- Conducts a weekly inspection of the waste storage areas of the laboratory.

1.9. Training and Orientation

1.9.1. Training for Pace employees is managed through a web-based Learning Management System. After a new employee has been instructed in matters of human resources, they are given instructional materials for the LMS and a password for access.

1.9.2. A new hire training checklist is provided to the new employee that lists training items for the employee to work through either independently on LMS or with their supervisor or trainer. The training items that can be completed independently include:

- Reading through applicable Standard Operating Procedures;
- Reviewing the Quality Manual and Chemical Hygiene Plan;
- Core training modules such as quality control indicators, basic laboratory skills, etc.;
- Quality Systems training including traceability of measurements, method calibration, calibration verification, accuracy, precision and uncertainty of measurements, corrective actions, documentation, and root cause analysis;
- Data Integrity/Ethics training.

1.9.3. The new employee's Department Supervisor provides the employee with a basic understanding of the role of the laboratory within the structure of PASI and the basic elements of that individual's position. Supervised training uses the following techniques:

- Hands-on training
- Training checklists/worksheets
- Lectures and training sessions
- Method-specific training
- Conferences and seminars
- Short courses
- Specialized training by instrument manufacturers
- Proficiency testing programs.
- On-line courses

1.9.4. Group Supervisors/Leaders are responsible for providing documentation of training and proficiency for each employee under their supervision. The employee's training file indicates what procedures an analyst or a technician is capable of performing, either independently or with supervision. The files also include documentation of continuing capability, which are fully detailed in Section 3.4. Training documentation files for each person are maintained by the Quality Office either in hardcopy format or within the LMS.

1.9.5. All procedures and training records are maintained and available for review during laboratory audits. These procedures are reviewed/updated periodically by laboratory management. Additional information can be found in SOP S-ALL-Q-020 **Training and Employee Orientation** or its equivalent revision or replacement.

1.10. Data Integrity System

1.10.1. The data integrity system at PASI provides assurances to management that a highly ethical approach is being applied to all planning, training and implementation of methods. Data integrity is crucial to the success of our company and Pace Analytical is committed to creating and maintaining a culture of quality throughout the organization. To accomplish this goal, PASI has implemented a data integrity system that encompasses the following four requirements:

1.10.1.1. A data integrity training program: standardized training is given to each new employee and a yearly refresher is presented to all employees. Key topics addressed by this training include:

1.10.1.1.1. Need for honesty and transparency in analytical reporting
1.10.1.1.2. Process for reporting data integrity issues
1.10.1.1.3. Specific examples of unethical behavior and improper practices
1.10.1.1.4. Documentation of non-conforming data that is still useful to the data user
1.10.1.1.5. Consequences and punishments for unethical behavior
1.10.1.1.6. Examples of monitoring devices used by management to review data and systems

1.10.1.2. Signed data integrity documentation for all employees: this includes a written quiz following the Ethics training session and written agreement to abide by the Code of Ethics and Standards of Conduct explained in the employee manual.

1.10.1.3. In-depth, periodic monitoring of data integrity including peer data review and validation, internal raw data audits, proficiency testing studies, etc.

1.10.1.4. Documentation of any review or investigation into possible data integrity infractions. This documentation, including any disciplinary actions involved, corrective actions taken, and notifications to customers must be retained for a minimum of five years.

1.10.2. PASI management makes every effort to ensure that personnel are free from any undue pressures that affect the quality of their work including commercial, financial, over scheduling, and working condition pressures.

1.10.3. Corporate management also provides all PASI facilities a mechanism for confidential reporting of data integrity issues that ensures confidentiality and a receptive environment in which all employees are comfortable discussing items of ethical concern. The anonymous message line is monitored by the Corporate Director of Quality who will ensure that all concerns are evaluated and, where necessary, brought to the attention of executive management and investigated. Any Pace employee can contact corporate management to report an ethical concern by calling the anonymous hotline at 612-607-6431.

1.11. Laboratory Safety

1.11.1. It is the policy of PASI to make safety and health an integral part of daily operations and to ensure that all employees are provided with safe working conditions, personal protective equipment, and requisite training to do their work without injury. Each employee is responsible for his/her own safety as well as those working in the immediate area by complying with established company rules and procedures. These rules and procedures as well as a more detailed description of the employees' responsibilities are contained in the corporate Safety Manual and Chemical Hygiene Plan.

1.12. Security and Confidentiality

1.12.1. Security is maintained by controlled access to laboratory buildings. Exterior doors to laboratory buildings remain either locked or continuously monitored by PASI staff. Keyless door lock combinations and computer access codes/logins are changed periodically. Posted signs direct visitors to the reception office and mark all other areas as off limits to unauthorized personnel. All visitors, including PASI staff from other facilities, must sign the Visitor's Logbook maintained by the receptionist. A staff member will accompany them during the duration of their stay on the premises unless the SGM/GM/AGM/OM, SQM/QM, or Technical Director specify otherwise. In this instance, the staff member will escort the visitor back to the reception area at the end of his/her visit where he/she signs out. The last staff member to leave their department for the day must ensure that all outside access points to that area are secure.

1.12.2. Additional security is provided where necessary, (e.g., specific secure areas for sample, data, and customer report storage), as requested by customers, or cases where national security is of concern. These areas are lockable within the facilities, or are securely offsite. Access is limited to specific individuals or their designees. Security of sample storage areas is the responsibility of the Sample Custodian. Security of samples and data during analysis and data reduction is the responsibility of Group Supervisors. Security of customer report archives is the responsibility of the Client Services Manager. These secure areas are locked whenever these individuals or their designees are not present in the facility.

1.12.3. Access to designated laboratory sample storage locations is limited to authorized personnel only. Provisions for lock and key access are provided. No samples are to be removed without proper

authorization. If requested by customer or contract, samples are not to be removed from secure storage areas without filling out an associated internal chain of custody.

1.12.4. Standard business practices of confidentiality are applied to all documents and information regarding customer analyses. Specific protocols for handling confidential documents are described in PASI SOPs. Additional protocols for sample identification by internal laboratory identification numbers only are implemented as required under contract specific Quality Assurance Project Plans (QAPPs).

1.12.5. All information pertaining to a particular customer, including national security concerns will remain confidential. Data will be released to outside agencies only with written authorization from the customer or where federal or state law requires the company to do so.

1.13. Communications

1.13.1. Management within each lab bears the responsibility of ensuring that appropriate communication processes are established and that communication takes place regarding the effectiveness of the management/quality system. These communication processes may include email, regular staff meetings, senior management meetings, etc.

1.13.2. Corporate management bears the responsibility of ensuring that appropriate communication processes are established within the network of facilities and that communication takes place at a company-wide level regarding the effectiveness of the management/quality systems of all Pace facilities. These communication processes may include email, quarterly continuous improvement conference calls for all lab departments, and annual continuous improvement meetings for all department supervisors, quality managers, client services managers, and other support positions.

2.0. SAMPLE CUSTODY

2.1. Sampling Support

2.1.1. Each individual PASI laboratory provides shipping containers, properly preserved sample containers, custody documents, and field quality control samples to support field-sampling events. Guidelines for sample container types, preservatives, and holding times for a variety of methods are listed in Attachment VIII. Note that all analyses listed are not necessarily performed at all PASI laboratories and there may be additional laboratory analyses performed that are not included in these tables. Customers are encouraged to contact their local Pace Project Manager for questions or clarifications regarding sample handling. PASI - Minneapolis, Billings, Virginia and Duluth may provide pick-up and delivery services to their customers when needed.

2.2. Field Services

2.2.1. Pace Analytical has a large Field Services Division which is based in their Minneapolis facility as well as limited field service capabilities in some of our other facilities. Field Services provides comprehensive nationwide service offerings including:

- Stack Testing
- Ambient Air
- CEM Certification Testing
- Air Quality Monitoring
- Onsite Analytical Services- FTIR and GC
- Real-time Process Diagnostic/Optimization Testing
- Wastewater, Groundwater and Drinking Water Monitoring
- Storm Water and Surface Water Monitoring
- Soil and Waste Sampling
- Mobile Laboratory Services

2.2.2. Field Services operates under the PASI Corporate Quality System, with applicable and necessary provisions to address the activities, methods, and goals specific to Field Services. All procedures and methods used by Field Services are documented in Standard Operating Procedures and Procedure Manuals.

2.3. Project Initiation

2.3.1. Prior to accepting new work, the laboratory reviews its performance capability. The laboratory confirms that sufficient personnel, equipment capacity, analytical method capability, etc., are available to complete the required work. Customer needs, certification requirements, and data quality objectives are defined and the appropriate sampling and analysis plan is developed to meet the project requirements by project managers or sales representatives. Members of the management staff review current instrument capacity, personnel availability and training, analytical procedures capability, and projected sample load. Management then informs the sales and client services personnel whether or not the laboratory can accept the new project via written correspondence, email, and/or daily operations meetings.

2.3.2. The laboratory maintains records of all such reviews, including discussions with customers. Routine analytical project documentation of quotes, notes, dates, initials, and/or recordings is maintained in a project folder by project management. Conditions for new and more complex contracts are determined by the SGM/GM/AGM/OM and sales representatives. Quality Management is consulted on technical requirements and operations staff provides input on volume capacities. Evidence of these reviews is maintained in the form of awarded Request for Proposals (RFPs), signed quotes or contracts, and a Customer Relationship Management (CRM) database. If a review identifies a potential mismatch between customer requirements and laboratory capabilities and/or capacities, Pace will specify its level of commitment by listing these exceptions to the requirements within the RFP, quote or contract.

2.3.3. Additional information regarding specific procedures for reviewing new work requests can be found in SOP S-MN-Q-270 **Review of Analytical Requests** or its equivalent revision or replacement.

2.4. Chain of Custody

2.4.1. A chain of custody (COC) provides the legal documentation of samples from time of collection to completion of analysis. PASI has implemented Standard Operating Procedures to ensure that sample custody traceability and responsibility objectives are achieved for every project.

2.4.2. Field personnel or client representatives must complete a chain of custody for all samples that are received by the laboratory. The importance of completeness of COCs is stressed to the samplers and is critical to efficient sample receipt and to insure the requested methods are used to analyze the correct samples.

2.4.3. If sample shipments are not accompanied by the correct documentation, the Sample Receiving department notifies a Project Manager. The Project Manager then obtains the correct documentation/information from the customer in order for analysis of samples to proceed.

2.4.4. The sampler is responsible for providing the following information on the chain of custody form:

- Customer project name
- Project location or number
- Field sample number/identification
- Date and time sampled
- Sample matrix
- Preservative
- Requested analyses
- Sampler signature
- Relinquishing signature
- Date and time relinquished
- Sampler remarks as needed
- Custody Seal Number if present
- Regulatory Program Designation
- The state where the samples were collected to ensure all applicable state requirements are met
- Turnaround time requested
- Purchase order number

2.4.5. The COC is filled out completely and legibly with indelible ink. Errors are corrected by drawing a single line through the initial entry and initialing and dating the change. All transfers of samples are recorded on the chain of custody in the "relinquished" and "received by" sections. All information except signatures is printed.

2.4.6. Additional information can be found in S-MN-C-001 **Sample Management** or its equivalent revision or replacement.

2.5. Sample Acceptance Policy

2.5.1. In accordance with regulatory guidelines, PASI complies with the following sample acceptance policy for all samples received.

2.5.2. If the samples do not meet the sample receipt acceptance criteria outlined below, the laboratory is required to document all non-compliances, contact the customer, and either reject the samples or fully document any decisions to proceed with analyses of samples which do not meet the criteria. Any results reported from samples not meeting these criteria are appropriately qualified on the final report.

2.5.2.1. For Ohio VAP samples, the narrative for any report that includes qualified data must also include a discussion of any bias in the results.

2.5.3. All samples must:

- Have unique customer identification that is clearly marked with indelible ink on durable waterproof labels affixed to the sample containers that match the chain of custody.
- Have clear documentation on the chain of custody related to the location of the sampling site with the time and date of sample collection.
- Have the sampler's name and signature.
- Have all requested analyses clearly designated on the COC.
- Have clear documentation of any special analytical or data reporting requirements.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be correctly preserved unless the method allows for laboratory preservation.
- Be received within holding time. Any samples with hold times that are exceeded will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges - not frozen but ≤6°C (See Note 1), unless program requirements or customer contractual obligations mandate otherwise (see Note 2). The cooler temperature is recorded directly on the COC and the SCUR. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.

Note 1: Temperature will be read and recorded based on the precision of the measuring device. For example, temperatures obtained from a thermometer graduated to 0.1°C will be read and recorded to

±0.1°C. Measurements obtained from a thermometer graduate to 0.5°C will be read to ±0.5°C. Measurements read at the specified precision are not to be rounded down to meet the ≤6°C limit

Note 2: Some microbiology methods allow sample receipt temperatures of up to 10°C. Consult the specific method for microbiology samples received above 6°C prior to initiating corrective action for out of temperature preservation conditions.

Note 3: Biological Tissue Samples must be received frozen at ≤0°C.

2.5.4. Upon sample receipt, the following items are also checked and recorded:

- Presence of custody seals or tapes on the shipping containers;
- Sample condition: Intact, broken/leaking, bubbles in VOA samples;
- Sample holding time;
- Sample pH and residual chlorine when required;
- Appropriate containers.

2.5.5. Samples for drinking water analysis that are improperly preserved, or are received past holding time, are rejected at the time of receipt, with the exception of VOA samples that are tested for pH at the time of analysis.

2.5.6. Additional information can be found in S-MN-C-001 **Sample Management** or its equivalent revision or replacement.

2.6. Sample Log-in

2.6.1. After sample inspection, all sample information on the chain of custody is entered into the Laboratory Information Management System (LIMS). This permanent record documents receipt of all sample containers including:

- Customer name and contact
- Customer number
- Pace Analytical project number
- Pace Analytical Project Manager
- Sample descriptions
- Due dates
- List of analyses requested
- Date and time of laboratory receipt
- Field ID code
- Date and time of collection
- Any comments resulting from inspection for sample rejection

2.6.2. All samples received are logged into the LIMS within one working day of receipt. Sample login may be delayed due to customer clarification of analysis needed, corrective actions for sample receipt non-conformance, or other unusual circumstances. If the time collected for any sample is unspecified and Pace is unable to obtain this information from the customer, the laboratory will use 00:00 as the time sampled. All hold times will be based on this sampling time and qualified accordingly if exceeded.

2.6.3. For DoD work, if the time of the sample collection is not provided, the laboratory must assume the most conservative time of day. This is defined as 12:01am.

2.6.4. The LIMS automatically generates a unique identification number for each sample created in the system. The LIMS sample number follows the general convention of BB-XXXXXX-YYY. The BB represents the laboratory identification within Pace's laboratory network. The 5 digit "X" number represents the project number followed by a 3 digit sample number. The project number is a sequential number that is assigned as a new project is created. The sample number corresponds to the number of samples submitted by the client. In addition to the unique sample ID, there is a sample container ID that consists of the sample number, the container type (e.g. BP1U), and bottle 1 of Y, where Y represents the total number of containers of that particular type. Together the sample LIMs number and sample container ID number create a unique barcode encryption that can be linked to the sample analysis requested by the client. This unique identification number is placed on the sample container as a durable label and becomes the link between the laboratory's sample management system and the customer's field identification; it will be a permanent reference number for all future interactions.

2.6.5. Current division codes are noted below. These division codes are used primarily for accounting purposes and LIMS sample identifications. For smaller facilities, these codes may be used primarily for accounting purposes. More division codes may be added, revised or removed without updating this document.

00 = Corporate
10 = Minnesota/Montana
12 = Virginia/Duluth MN
20 = New Orleans/Puerto Rico
30 = Pittsburgh
35 = Florida/South Florida
36 = South Florida (accounting only)
40 = Green Bay
50 = Indianapolis/Columbus
51 = Columbus (accounting only)
55/56 = Pace Energy Labs
60 = Kansas
65 = New York (Schenectady)
70 = Long Island
75 = Dallas
92 = Carolinas

2.6.6. Sample labels are printed from the LIMS and affixed to each sample container.

2.6.7. Samples with hold times that are near expiration date/time may be sent directly to the laboratory for analysis at the discretion of the Project Manager and/or SGM/GM/AGM/OM.

2.6.8. Additional information can be found in S-MN-C-001 **Sample Management** or its equivalent revision or replacement.

2.7. Sample Storage

2.7.1. Storage Conditions

2.7.1.1. Samples are stored away from all standards, reagents, or other potential sources of contamination. Samples are stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

2.7.1.2. Storage blanks, consisting of two 40mL aliquots of reagent water, are stored with volatile samples and are used to measure cross-contamination acquired during storage. If applicable, laboratories must have documented procedures and criteria for evaluating storage blanks, appropriate to the types of samples being stored.

2.7.1.3. Additional information can be found in S-MN-Q-263 **Monitoring Temperature Controlled Units.**

2.7.2. Temperature Monitoring

2.7.2.1. Samples are taken to the appropriate storage location immediately after sample receipt and check-in procedures are completed. All sample storage areas are located in limited access areas and are monitored to ensure sample integrity.

2.7.2.2. The temperature of each refrigerated storage area is maintained at ≤6°C (but above freezing) unless state or program requirements differ. The temperature of each freezer storage area is maintained at <-10°C unless state or program requirements differ. The temperature of each storage area is checked and documented each day of use (each calendar day). If the temperature falls outside the acceptable limits, the following corrective actions are taken and appropriately documented:

- The temperature is rechecked after two hours to verify temperature exceedance. Corrective action is initiated and documented if necessary.
- The SQM/QM and/or laboratory management are notified if the problem persists.
- The samples are relocated to a proper environment if the temperature cannot be maintained after corrective actions are implemented.
- The affected customers are notified.
- Documentation is provided on analytical report.

Additional information can be found in S-MN-Q-263 **Monitoring Temperature Controlled Units.**

2.7.3. Hazardous Materials

2.7.3.1. Pure product or potentially heavily contaminated samples must be tagged as "hazardous" or "lab pack" and stored separately from other samples.

2.7.4. Foreign/Quarantined Soils

2.7.4.1. Depending on the soil disposal practices of the laboratory, foreign soils and soils from USDA regulated areas are adequately segregated to enable proper sample disposal. The USDA requires these samples to be incinerated or sterilized by an approved treatment procedure. Additional information regarding USDA regulations and sample handling can be found in applicable local laboratory SOPs.

2.7.4.2. Additional information on sample storage can be found in S-MN-C-001 **Sample Management** or its equivalent revision or replacement and in S-MN-S-003 **Waste Handling and Management.**

2.8. Sample Protection

2.8.1. PASI laboratory facilities are operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times.

2.8.2. Samples are removed from storage areas by designated personnel and returned to the storage areas, if necessary, immediately after the required sample quantity has been taken.

2.8.3. Upon customer request, additional and more rigorous chain of custody protocols for samples and data can be implemented. For example, some projects may require internal chain-of-custody protocols.

2.8.4. Additional information can be found in S-MN-C-001 **Sample Management** or its equivalent revision or replacement.

2.9. Subcontracting Analytical Services

2.9.1. Every effort is made to perform all analyses for PASI customers within the laboratory that receives the samples. When subcontracting to a laboratory other than the receiving laboratory, whether inside or outside the PASI network, becomes necessary, a preliminary verbal communication with that laboratory is undertaken. Customers are notified in writing of the laboratory's intention to subcontract any portion of the testing to another laboratory. Work performed under specific protocols may involve special considerations.

2.9.2. Prior to subcontracting samples to a laboratory outside Pace Analytical, the potential subcontract laboratory will be pre-qualified by verifying that the subcontractor meets the following criteria:

- All certifications required for the proposed subcontract are in effect,
- Sufficient professional liability and other required insurance coverage is in effect, and
- Is not involved in legal action by any federal, state, or local government agency for data integrity issues and has not been convicted in such investigation at any time during the past 5 years.

2.9.3. The contact and preliminary arrangements are made between the PASI Project Manager and the appropriate subcontract laboratory personnel. The specific terms of the subcontract laboratory agreement include:

- Method of analysis
- Number and type of samples expected
- Project specific QA/QC requirements
- Deliverables required
- Laboratory certification requirement
- Price per analysis
- Turn-around time requirements

2.9.4. Chain-of-custody forms are generated for samples requiring subcontracting to other laboratories. Sample receiving personnel re-package the samples for shipment, create a transfer chain of custody form and record the following information:

- Pace Analytical Laboratory Number
- Matrix
- Requested analysis
- Special instructions regarding turnaround, required detection or reporting limits, or any unusual information known about the samples or analytical procedure.
- Signature in "Relinquished By"

2.9.5. All subcontracted sample data reports are sent to the PASI Project Manager. Pace will provide a copy of the subcontractor's report to the client when requested.

2.9.6. Any Pace Analytical work sent to other labs within the PASI network is handled as subcontracted work and all final reports are labeled clearly with the name of the laboratory performing

the work. Any non-TNI work is clearly identified. PASI will not be responsible for analytical data if the subcontract laboratory was designated by the customer.

2.9.7. Additional information can be found in S-MN-C-004 **Subcontracting Samples** or its equivalent revision or replacement.

2.9.8. Subcontracted labs used for DoD work must be accredited by DoD or its designated representatives. Subcontracted labs must receive project specific approval from the DoD client before any samples are analyzed. These requirements also apply to the use of any laboratory under the same corporate umbrella, but at a different facility or location.

2.10. Sample Retention and Disposal

2.10.1. Samples, extracts, digestates, and leachates must be retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

- Air canisters are submitted for cleaning upon data validation. Due to media capacity, air canister samples are not retained as standard environmental samples.

2.10.2. Unused portions of samples are retained by each laboratory based on program or customer requirements for sample retention and storage. The minimum sample retention time is 45 days from receipt of the samples. Samples requiring thermal preservation may be stored at ambient temperature when the hold time is expired, the report has been delivered, and/or allowed by the customer, program, or contract. Samples requiring storage beyond the minimum sample retention time due to special requests or contractual obligations may be stored at ambient temperature unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

2.10.3. After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer. If it is not feasible to return samples, or the customer requires PASI to dispose of excess samples, proper arrangements will be made for disposal by an approved contractor.

2.10.4. Additional information can be found in S-MN-S-003 **Waste Handling and Management** and S-MN-C-001 or their equivalent revisions or replacements.

3.0. ANALYTICAL CAPABILITIES

3.1. Analytical Method Sources

3.1.1. PASI laboratories are capable of analyzing a full range of environmental samples from a variety of matrices, including air, surface water, wastewater, groundwater, soil, sediment, biota, and other waste products. The latest valid editions of methodologies are applied from regulatory and professional sources including EPA, ASTM, USGS, NIOSH, Standard Methods, and State Agencies. Section 11 is a representative listing of general analytical protocol references. PASI discloses in writing to its customers and regulatory agencies any instances in which modified methods are being used in the analysis of samples.

3.1.2. In the event of a customer-specific need, instrumentation constraint or regulatory requirement, PASI laboratories reserve the right to use valid versions of methods that may not be the most recent edition available.

3.2. Analytical Method Documentation

3.2.1. The primary form of PASI laboratory documentation of analytical methods is the Standard Operating Procedure (SOP). SOPs contain pertinent information as to what steps are required by an analyst to successfully perform a procedure. The required contents for the SOPs are specified in the company-wide SOP for Preparation of SOPs (S-ALL-Q-001).

3.2.2. The SOPs may be supplemented by other training materials that further detail how methods are specifically performed. This training material will undergo periodic, documented review along with the other Quality System documentation.

3.3. Analytical Method Validation and Instrument Validation

3.3.1. In some situations, PASI develops and validates methodologies that may be more applicable to a specific problem or objective. When non-standard methods are required for specific projects or analytes of interest, or when the laboratory develops or modifies a method, the laboratory validates the method prior to applying it to customer samples. Method validity is established by meeting criteria for precision and accuracy as established by the data quality objectives specified by the end user of the data. The laboratory records the validation procedure, the results obtained and a statement as to the usability of the method. The minimum requirements for method validation include evaluation of sensitivity, quantitation, precision, bias, and selectivity of each analyte of interest.

3.3.2. Additional information can be found in SOP S-MN-Q-252 **Method Validation and Modification Studies**, or equivalent replacement.

3.4. Demonstration of Capability (DOC)

3.4.1. Analysts complete an initial demonstration of capability (IDOC) study prior to performing a method or when there is a change in instrument type, personnel, or test method, or at any time that a method has not been performed by the laboratory or analyst in a 12-month period. The mean recovery and standard deviation of each analyte, taken from 4 replicates of a quality control standard is calculated and compared to method criteria (if available) or established laboratory criteria for evaluation of acceptance. Each laboratory maintains copies of all demonstrations of capability,

including those that fail acceptance criteria and corresponding raw data for future reference and must document the acceptance criteria prior to the analysis of the DOC. Demonstrations of capability are verified on an annual basis.

3.4.2. For Continuing Demonstrations of Capability, the laboratories may use Performance Testing (PT) samples in lieu of the 4-replicate approach listed above. For methods or procedures that do not lend themselves to the "4-replicate" approach, the demonstration of capability requirements will be specified in the applicable SOP. Drinking Water DOCs must be done at or below the MCL.

3.4.3. Additional information can be found in SOP S-ALL-Q-020 **Training and Employee Orientation** or its equivalent revision or replacement.

3.5. Regulatory and Method Compliance

3.5.1. PASI understands that expectations of our customers commonly include the assumption that laboratory data will satisfy specific regulatory requirements. Therefore PASI attempts to ascertain, prior to beginning a project, what applicable regulatory jurisdiction, agency, or protocols apply to that project. This information is also required on the chain of custody submitted with samples.

3.5.2. PASI makes every effort to detect regulatory or project plan inconsistencies, based upon information from the customer, and communicate them immediately to the customer in order to aid in the decision making process. PASI will not be liable if the customer chooses not to follow PASI recommendations.

3.5.3. It is PASI policy to disclose in a forthright manner any detected noncompliance affecting the usability of data produced by our laboratories. The laboratory will notify customers within 30 days of fully characterizing the nature of the nonconformance, the scope of the nonconformance and the impact it may have on data usability.

4.0. QUALITY CONTROL PROCEDURES

The method SOPs will define the following criteria in a more detailed procedures for the corrective actions as applicable to each analytical method. Quality control data is analyzed and where they are found to be outside pre-defined criteria, planned action is taken to correct the problem in order to prevent incorrect results from being reported. Quality control samples are to be processed in the same manner as client samples.

4.1. Method Blank

4.1.1. A method blank is used to evaluate contamination in the preparation/analysis system and is processed through all preparation and analytical steps with its associated samples.

4.1.2. A method blank is processed at a minimum frequency of one per preparation batch (see glossary section of this document for further clarification of the definition of batch). In the case of a method that has no separate preparation step, a method blank is processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

4.1.3. The method blank consists of a matrix similar to the associated samples that is known to be free of analytes of interest. Method blanks are not applicable for certain analyses, such as pH, conductivity, flash point and temperature.

4.1.4. Each method blank is evaluated for contamination. The source of any contamination is investigated and documented corrective action is taken when the concentration of any target analyte is detected above the reporting limit and is greater than 1/10 of the amount of that analyte found in any associated sample. Some labs, due to client requirements, etc., may have to evaluate their method blanks down to ½ the reporting limit or down to the method detection limit as opposed to the reporting limit itself. Corrective actions for blank contamination may include the re-preparation and re-analysis of all samples (where possible) and quality control samples. Data qualifiers must be applied to results that are considered affected by contamination in a method blank.

4.1.5. For DoD samples, the method blank will be considered to be contaminated if: 1) The concentration of any target analyte in the blank exceeds 1/2 the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater; 2) The concentration of any common laboratory contaminant in the blank exceeds the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater or 3) The blank result otherwise affects the sample results as per the test method requirements or the project-specific objectives. If the method blank is contaminated as described above, then the laboratory shall reprocess affected samples in a subsequent preparation batch, except when sample results are below the LOD. If insufficient sample volume remains for reprocessing, the results shall be reported with appropriate data qualifiers.

4.1.6. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.1.7. For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of method blank having any reportable contamination, the laboratory is required to reanalyze the associated samples with an acceptable method blank if there is sufficient sample remaining. Acceptable method blanks are those that are free of contamination below the reporting limit. The laboratory must make every effort to take the appropriate corrective actions and resolve any

anomalies regarding method blanks for Ohio VAP projects. The narrative for any report that includes qualified data must also include a discussion of any bias in the results.

4.2. Laboratory Control Sample

4.2.1. The Laboratory Control Sample (LCS) is used to evaluate the performance of the entire analytical system including preparation and analysis.

4.2.2. An LCS is processed at a minimum frequency of one per preparation batch. In the case of a method that has no separate preparation step, an LCS will be processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

4.2.3. The LCS consists of a matrix similar to the associated samples that is known to be free of the analytes of interest that is then spiked with known concentrations of target analytes.

4.2.4. The LCS contains **all** analytes specified by a specific method or by the customer or regulatory agency, which may include full list of target compounds, with certain exceptions. These exceptions may include analyzing only specific Aroclors when PCB analysis is requested or not spiking with all EPA Appendix IX compounds when a full Appendix IX list of compounds is requested. However, the lab must ensure that all target components in its scope of accreditation are included in the spike mixture for the LCS over a two (2) year period. In the absence of specified components, the laboratory will spike the LCS with the following compounds:

- For multi-peak analytes (e.g. PCBs, technical chlordane, toxaphene), a representative standard will be processed.
- For methods with long lists of analytes, a representative number of target analytes may be chosen. The following criteria is used to determine the number of LCS compounds used:
  - For methods with 1-10 target compounds, the laboratory will spike with all compounds;
  - For methods with 11-20 target compounds, the laboratory will spike with at least 10 compounds or 80%, whichever is greater;
  - For methods with greater than 20 compounds, the laboratory will spike with at least 16 compounds.

Note: This is not approved for South Carolina. South Carolina samples must be re-extracted and re-analyzed to report data with no recoveries exceeding limits.

4.2.5. The LCS is evaluated against the method default or laboratory-derived acceptance criteria. For those methods that require laboratory-derived limits, method default control limits may be used until the laboratory has a minimum of 20, but preferably greater than 30, data points from which to derive internal acceptance criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Any associated sample containing an 'out-of-control' compound must either be re-analyzed with a successful LCS or reported with the appropriate data qualifier. When the acceptance criteria for the LCS are exceeded high, and there are associated samples that are non-detects, then those non-detects can be reported with data qualifiers, or when the acceptance criteria are exceeded low, those associated sample results may be reported if they exceed the maximum regulatory limit/decision level with data qualifiers.

4.2.6. For LCSs containing a large number of analytes, it is statistically likely that a few recoveries will be outside of control limits. This does not necessarily mean that the system is out of control, and therefore no corrective action would be necessary (except for proper documentation). TNI has allowed for a minimum number of marginal exceedances, defined as recoveries that are beyond the LCS control limits (3X the standard deviation) but less than the marginal exceedance limits (4X the

standard deviation). The number of allowable exceedances depends on the number of compounds in the LCS. If more analyte recoveries exceed the LCS control limits than is allowed (see below) or if any one analyte exceeds the marginal exceedance limits, then the LCS is considered non-compliant and corrective actions are necessary. The number of allowable exceedances is as follows:

- >90 analytes in the LCS- 5 analytes
- 71-90 analytes in the LCS- 4 analytes
- 51-70 analytes in the LCS- 3 analytes
- 31-50 analytes in the LCS- 2 analytes
- 11-30 analytes in the LCS- 1 analyte
- <11 analytes in the LCS- no analytes allowed out)

  Note: This is not approved for South Carolina. South Carolina samples must be re-extracted and re-analyzed to report data with no recoveries exceeding limits.

4.2.7. A matrix spike (MS) can be used in place of a non-compliant LCS in a batch as long as the MS passes the LCS acceptance criteria (this is a TNI allowance). When this happens, full documentation must be made available to the data user. If this is not allowed by a customer or regulatory body, the associated samples must be rerun with a compliant LCS (if possible) or reported with appropriate data qualifiers.

Note: This is not approved for South Carolina. South Carolina samples must be re-extracted and re-analyzed to report data with no recoveries exceeding limits.

4.2.8. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.2.9. For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of LCS failures, the laboratory is required to reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio VAP projects. The narrative for any report that includes qualified data must also include a discussion of any bias in the results.

- For Ohio VAP projects, the MS cannot be used in place of the LCS.

4.2.10. For Department of Defense projects, the laboratory is not allowed to have any target analytes that exceed DoD LCS control limits. In the case of LCS failures, the laboratory is required to reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Department of Defense projects. All LCS failures must be accounted for in project case narratives. See applicable method SOPs for further corrective action.

4.3. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

4.3.1. A matrix spike (MS) is used to determine the effect of the sample matrix on compound recovery for a particular method. The information from these spikes is sample or matrix specific and is not used to determine the acceptance of an entire batch unless the MS is actually used as the LCS.

4.3.2. A **Matrix Spike/Matrix Spike Duplicate** (MS/MSD) set is processed at a frequency specified in a particular method or as determined by a specific customer request. This frequency will

be specified in the applicable method SOP or customer QAPP. In the absence of such requirements, an MS/MSD set is routinely analyzed once per every 20 samples per matrix per method.

4.3.3. The MS and MSD consist of the sample matrix that is then spiked with known concentrations of target analytes. Laboratory personnel spike customer samples that are specifically designated as MS/MSD samples or, when no designated samples are present in a batch, randomly select samples to spike that have adequate sample volume or weight. Spiked samples are prepared and analyzed in the same manner as the original samples and are selected from different customers if possible.

4.3.4. The MS and MSD contain all analytes specified by a specific method or by the customer or regulatory agency. In the absence of specified components, the laboratory will spike the MS/MSD with the same number of compounds as previously discussed in the LCS section. However, the lab must ensure that all targeted components in its scope of accreditation are included in the spike mixture for the MS/MSD over a two (2) year period.

4.3.5. The MS and MSD are evaluated against the method or laboratory derived criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Batch acceptance, however, is based on method blank and LCS performance, not on MS/MSD recoveries. The spike recoveries give the data user a better understanding of the final results based on their site specific information.

4.3.6. A matrix spike and sample duplicate will be performed instead of a matrix spike and matrix spike duplicate when specified by the customer or method.

4.3.7. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.3.8. For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of MS/MSD failures, the laboratory is required to reanalyze the associated samples only when the associated LCS also fails acceptance criteria and if there is sufficient sample remaining. When an LCS is acceptable and the MS results are outside of criteria, and no system anomaly is detected, the samples will be reported with appropriate data qualifiers indicating matrix interference. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio VAP projects.

- For Ohio VAP projects MS/MSD are optional and will be directed by the Certified Professional.

4.3.9. For DoD work, each preparation batch of samples must contain an associated MS and MSD (or sample duplicate) using the same matrix collected for the specific DoD project. If adequate sample material is not available, then the lack of MS/MSDs shall be noted in the case narrative. Additional MS/MSDs may be required on a project-specific basis. The MS/MSD must be spiked with all target analytes with the exception of PCB analysis, which is spiked per the method. The concentration of the spiked compounds shall be at or below the midpoint of the calibration range or at the appropriate concentration of concern. Multiple spiked samples may need to be prepared to avoid interferences.

4.3.10. For DoD work, the results of all MS/MSD must be evaluated using the same acceptance criteria used for the LCS.

4.4. Sample Duplicate

4.4.1. A sample duplicate is a second portion of sample that is prepared and analyzed in the laboratory along with the first portion. It is used to measure the precision associated with preparation and analysis. A sample duplicate is processed at a frequency specified by the particular method or as determined by a specific customer.

- For Ohio VAP projects Sample duplicate is optional and will be directed by the Certified Professional.

4.4.2. The sample and duplicate are evaluated against the method or laboratory derived criteria for relative percent difference (RPD). Any duplicate that is outside of these limits is considered to be 'out of control' and must be qualified appropriately.

4.4.3. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.4.4. For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of duplicate samples exceeding the RPD criteria found in applicable analytical SOPs, the laboratory is required to reanalyze the associated sample and duplicate as long as no sampling error was detected if there is sufficient sample remaining. If the sample and duplicate still do not agree, a comment would be made stating there may be sample non-homogeneity. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding sample duplicates for Ohio VAP projects. The narrative for any report that includes qualified data must also include a discussion of any bias in the results.

4.5. Surrogates

4.5.1. Surrogates are compounds that reflect the chemistry of target analytes and are typically added to samples for organic analyses to monitor the effect of the sample matrix on compound recovery.

4.5.1.1. Surrogates are added to each customer sample (for applicable organics), method blank, LCS, MS, and calibration standard prior to extraction or analysis. The surrogates are evaluated against the method or laboratory derived acceptance criteria or against project-specific acceptance criteria specified by the client, if applicable. Any surrogate compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Samples with surrogate failures are typically re-extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error. An exception to this would be samples that have high surrogate values but no reportable hits for target compounds. These samples would be reported, with a qualifier, because the implied high bias would not affect the final results. For methods with multiple surrogates, documentation regarding acceptance and associated compounds will be found in the individual method SOPs.

4.5.1.2. For Ohio VAP samples, the narrative for any report that includes qualified data must also include a discussion of any bias in the results.

4.5.1.3. For the TO-15 method, surrogates are not evaluated for Ohio VAP samples.

4.5.2. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.6. Internal Standards

4.6.1. Internal Standards are method-specific analytes added to every standard, method blank, laboratory control sample, matrix spike, matrix spike duplicate, sample, and calibration standard at a known concentration, prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. At a minimum, the laboratory will follow method specific guidelines for the treatment of internal standard recoveries as they are related to the reporting of data. Deviations made from this policy must be approved by the SQM/QM prior to release of the data.

4.6.2. For Ohio VAP projects, samples with internal standard that are outside of method criteria must be reanalyzed to confirm sample matrix effect. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding internal standards for Ohio VAP projects. The narrative for any report that includes qualified data must also include a discussion of any bias in the results.

4.7. Field Blanks

4.7.1. Field blanks are blanks prepared at the sampling site in order to monitor for contamination that may be present in the environment where samples are collected. These field quality control samples are often referenced as field blanks, rinsate blanks, or equipment blanks. The laboratory analyzes these field blanks as normal samples and informs the customer if there are any target compounds detected above the reporting limits.

4.8. Trip Blanks

4.8.1. Trip blanks are blanks that originate from the laboratory as part of the sampling event and are used to monitor for contamination of samples during transport. These blanks accompany the empty sample containers to the field and then accompany the collected samples back to the laboratory. These blanks are routinely analyzed for volatile methods where ambient background contamination is likely to occur.

4.9. Limit of Detection (LOD)

4.9.1. PASI laboratories are required to use a documented procedure to determine a limit of detection for each analyte of concern in each matrix reported. All sample processing steps of the preparation and analytical methods are included in this determination including any clean ups. For any test that does not have a valid LOD, sample results below the limit of quantitation (LOQ) cannot be reported.

4.9.2. The LOD is initially established for the compounds of interest for each method in a clean matrix with no target analytes present and no interferences at a concentration that would impact the results. The LOD is then determined every time there is a change in the test method that affects how the test is performed or when there has been a change in the instrument that affects the sensitivity. If required by customer, method or accreditation body, the LOD will be re-established annually for all applicable methods.

4.9.3. Unless otherwise noted, the method used by PASI laboratories to determine LODs is based on the Method Detection Limit (MDL) procedure outlined in 40 CFR Part 136, Appendix B. Where required by regulatory program or customer, the above referenced procedure will be followed.

4.9.4. Where specifically stated in the published method, LODs or MDLs will be performed at the listed frequency.

4.9.5. The validity of the LOD must be shown by detection (a value above zero) of the analytes in a QC sample in each quality system matrix. The QC sample must contain the analyte at no more than 3X the LOD for a single analyte test and 4X the LOD for multiple analyte tests. This verification must be performed on each instrument used for sample analysis and reporting of data. The validity of the LOD must be verified as part of the LOD determination process. This verification must be done prior to the use of the LOD for sample analysis.

4.9.6. An LOD study is not required for any analyte for which spiking solutions or quality control samples are not available such as temperature.

4.9.7. The LOD, if required, shall be verified annually for each quality system matrix, technology and analyte. In lieu of performing full LOD (MDL) studies annually, the laboratory can verify the LOD (MDL) on an annual basis, providing this verification is fully documented and does not contradict other customer or program requirements that the laboratory must follow. The requirements of this verification are:

- The spike concentration of the verification must be no more than 3X times the LOD for single analyte tests and 4X the LOD for multiple analyte tests.
- The laboratory must verify the LOD on each instrument used for the reporting of sample data.
- The laboratory must be able to identify all target analytes in the verification standard (distinguishable from noise).

4.9.8. For Ohio VAP projects, a valid MDL must be in place prior to sample analysis. MDLs must be spiked at or below the reporting limit and will not be accepted if it was spike higher than the reporting limit.

4.9.9. DoD definition for LOD- The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate is 1%.

4.9.10. Additional information can be found in SOP S-MN-Q-269 **Determination of LOD and LOQ** or its equivalent revision or replacement.

4.10. Limit of Quantitation (LOQ)

4.10.1. A limit of quantitation (LOQ) for every analyte of concern must be determined. For PASI laboratories, this LOQ is referred to as the RL, or Reporting Limit. This RL is based on the lowest calibration standard concentration that is used in each initial calibration. Results below this level are not allowed to be reported without qualification since the results would not be substantiated by a calibration standard. For methods with a determined LOD, results can be reported out below the LOQ but above the LOD if they are properly qualified (e.g., J flag).

4.10.2. The LOQ must be higher than the LOD.

4.10.3. To verify the LOQ, the laboratory will prepare a sample in the same matrix used for the LCS. The sample will be spiked with each target analyte at a concentration equivalent to the RL or 2X the RL. This sample must undergo the routine sample preparation procedure including any routine sample cleanup steps. The sample is then analyzed and the recovery of each target analyte determined. The recovery for each target analyte must meet the laboratories current control limits for an LCS. The annual LOQ verification is not required if the LOD was determined or verified annually on that instrument.

4.10.4. For DoD approved methods, the LOQ and LOD shall be verified quarterly and valid LOQ must be in place prior to sample analysis.

4.10.5. Additional information can be found in SOP S-MN-Q-269 **Determination of LOD and LOQ** or its equivalent revision or replacement.

4.11. Estimate of Analytical Uncertainty

4.11.1. PASI laboratories can provide an estimation of uncertainty for results generated by the laboratory. The estimate quantifies the error associated with any given result at a 95% confidence interval. This estimate does not include bias that may be associated with sampling. The laboratory has a procedure in place for making this estimation. In the absence of a regulatory or customer-specific procedure, PASI laboratories base this estimation on the recovery data obtained from the Laboratory Control Spikes. The uncertainty is a function of the standard deviation of the recoveries multiplied by the appropriate Student's t Factor at 95% confidence. Additional information pertaining to the estimation of uncertainty and the exact manner in which it is derived are contained in the SOP S-MN-Q-255 **Estimation of Measurement Uncertainty** or its equivalent revision or replacement.

4.11.2. The measurement of uncertainty is provided only on request by the customer, as required by specification or regulation and when the result is used to determine conformance within a specification limit.

4.12. Proficiency Testing (PT) Studies

4.12.1. PASI laboratories participate in the TNI defined proficiency testing program. PT samples are obtained from TNI and state regulatory approved providers and analyzed and reported at a minimum of two times per year for the relevant fields of testing per matrix.

4.12.2. The laboratory initiates an investigation whenever PT results are deemed 'unacceptable' by the PT provider. All findings and corrective actions taken are reported to the SQM/QM or their designee. A corrective action plan is initiated and this report is sent to the appropriate state accreditation agencies for their review. Additional PTs will be analyzed and reported as needed for certification purposes.

4.12.3. PT samples are treated as typical customer samples, utilizing the same staff, methods, equipment, facilities, and frequency of analysis. PT samples are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

4.12.4. Comparison of analytical results with anyone participating in the same PT study is prohibited prior to the close of the study.

4.12.5. Additional information can be found in SOP S-MN-Q-258 **Proficiency Testing Program** or its equivalent revision or replacement.

4.13. Rounding and Significant Figures

4.13.1. In general, the PASI laboratories report data to no more than three significant digits. Therefore, all measurements made in the analytical process must reflect this level of precision. In the event that a parameter that contributes to the final result has less than three significant figures of precision, the final result must be reported with no more significant figures than that of the

parameter in question. The rounding rules listed below are descriptive of the LIMS and not necessarily of any supporting program such as Excel.

4.13.2. Data is compared to the reporting limits and MDLs to determine if qualifiers are needed before the rounding step occurs.

4.13.3. **Rounding:** PASI- Minneapolis, Billings, Virginia and Duluth follow the odd / even guidelines for rounding numbers:

- If the figure following the one to be retained is less than five, that figure is dropped and the retained ones are not changed (with three significant figures, 2.544 is rounded to 2.54).
- If the figure following the ones to be retained is greater than five, that figure is dropped and the last retained one is rounded up (with three significant figures, 2.546 is rounded to 2.55).
- If the figure following the ones to be retained is five and if there are no figures other than zeros beyond that five, then the five is dropped and the last figure retained is unchanged if it is even and rounded up if it is odd (with three significant figures, 2.525 is rounded to 2.52 and 2.535 is rounded to 2.54).

4.13.4. **Significant Digits**

4.13.4.1. PASI- Minneapolis, Billings, Virginia and Duluth follow the following convention for reporting to a specified number of significant figures. Unless specified by federal, state, or local requirements or on specific request by a customer, the laboratory reports:

Values > 10 – Reported to 3 significant digits
Values ≤ 10 – Reported to 2 significant digits

4.14. Retention Time Windows

4.14.1. When chromatographic conditions are changed, retention times and analytical separations are often affected. As a result, two critical aspects of any chromatographic method are the determination and verification of retention times and analyte separation. Retention time windows must be established for the identification of target analytes. The retention times of all target analytes in all calibration verification standards must fall within the retention time windows. If an analyte falls outside the retention time window in an ICV or CCV, new absolute retention time windows must be calculated, unless instrument maintenance fixes the problem. When a new column is installed, a new retention time window study must be performed.

4.14.2. One process for the production of retention time windows: Make 3 injections of all single component or multi-component analytes over a 72-hour period. Record the retention time in minutes for each analyte and surrogate to 3 decimal places. Calculate the mean and standard deviation of the three absolute retention times for each target analyte and surrogate. For multi-component analytes, choose 3-5 major peaks and calculate the mean and standard deviation for each of the peaks. If the standard deviation of the retention times of a target analyte is 0.000, the lab may use a default standard deviation of 0.01. The width of the retention time window for each analyte and surrogate and major peak in a multi-component analyte is defined as +/- 3 times the standard deviation of the mean absolute retention time established during that 72-hour period or 0.03 minutes, whichever is greater.

4.14.3. The center of the retention time window is established for each analyte and surrogate by using the absolute retention times from the CCV at the beginning of the analytical shift. For samples

run with an initial calibration, use the retention time of the mid-point standard of the initial calibration curve..

4.14.4. For more information, please reference the local facility's analytical SOPs.

5.0. DOCUMENT MANAGEMENT AND CHANGE CONTROL

5.1. Document Management

5.1.1. Additional information can be found in SOP S-MN-Q-258 **Document Control and Management** or its equivalent revision or replacement. Information on Pace's policy for electronic signatures can also be found in this SOP.

5.1.2. Pace Analytical Services, Inc. has an established procedure for managing documents that are part of the quality system. The list of managed documents includes, but is not limited to, Standard Operating Procedures (both technical and non-technical), Quality Assurance Manuals, quality policy statements, training documents, work-processing documents, charts, posters, memoranda, notices, forms, software, and any other procedures, tables, plans, etc. that have a direct bearing on the quality system (including applicable data records and non-technical documents).

5.1.3. A master list of all managed documents is maintained at each facility identifying the current revision status and distribution of the controlled documents. This establishes that there are no invalid or obsolete documents in use in the facility. All documents are reviewed periodically and revised if necessary. Obsolete documents are systematically discarded or archived for audit or knowledge preservation purposes. Copies of all quality systems documentation provided to DoD for review must be in English.

5.1.4. Each managed document is uniquely identified to include the date of issue, the revision identification, page numbers, the total number of pages and the issuing authorities. For complete information on document numbering, refer to SOP S-MN-Q-258 **Document Numbering**.

5.1.5. SOPs, specifically, are available to all laboratory staff via the Learning Management System (LMS) which is a secure repository that is accessed through an internet portal. As a local alternative to the hard copy system of controlled documents, secured electronic copies of controlled documents may be maintained on the laboratory's local server. These document files must be read-only for all personnel except the Quality Department and system administrator. Other requirements for this system are as follows:

- Electronic documents must be readily accessible to all facility employees.
- Electronic documents must be locked from printing. All hardcopy SOPs must be obtained from the Quality Department.

5.1.6. **Quality Assurance Manual (QAM):** The Quality Assurance Manual is the company-wide document that describes all aspects of the quality system for PASI. The base QAM template is distributed by the Corporate Quality Department to each of the SQMs/QMs. The local management personnel modify the necessary and permissible sections of the base template and submit those modifications to the Corporate Director of Quality for review. Once approved and signed by both the CEO and the Director of Quality; the SGM/GM/AGM/OM, the SQM/QM, and any Technical Directors sign the Quality Assurance Manual. Each SQM/QM is then in charge of distribution to employees, external customers or regulatory agencies and maintaining a distribution list of controlled document copies. The Quality Assurance Manual template is reviewed on an annual basis by all of the PASI SQMs/QMs and revised accordingly by the Director of Quality.

5.1.7. Standard Operating Procedures (SOPs)

5.1.7.1. SOPs fall into two categories: company-wide documents and facility specific documents. Company-wide SOPs start with the prefix S-ALL- and local SOPs start with the individual facility prefix.

5.1.7.2. The purpose of the company-wide SOPs is to establish policies and procedure that are common and applicable to all PASI facilities. Company-wide SOPs are document-controlled by the corporate quality office and signed copies are distributed to all of the SQMs/QMs. The local management personnel sign the company-wide SOPs. The SQM/QM is then in charge of distribution to employees, external customers, or regulatory agencies and maintaining a distribution list of controlled document copies.

5.1.7.3. Local PASI facilities are responsible for developing facility-specific SOPs applicable to their respective facility. The local facility develops these facility-specific SOPs based on the corporate-wide SOP template. This template is written to incorporate a set of minimum method requirements and PASI best practice requirements. The local facilities may add to or modify the corporate-wide SOP template provided there are no contradictions to the minimum method or best practice requirements. Facility-specific SOPs are controlled by the applicable SQM/QM according to the corporate document management policies.

5.1.7.4. SOPs are reviewed every two years at a minimum although a more frequent review may be required by some state or federal agencies or customers. If no revisions are made based on this review, documentation of the review itself is made by the addition of new signatures on the cover page. If revisions are made, documentation of the revisions is made in the revisions section of each SOP and a new revision number is applied to the SOP. This provides a historical record of all revisions.

5.1.7.5. All copies of superseded SOPs are removed from general use and the original copy of each SOP is archived for audit or knowledge preservation purposes. This ensures that all PASI employees use the most current version of each SOP and provides the SQM/QM with a historical record of each SOP.

5.1.7.6. Additional information can be found in SOP S-MN-Q-273 **Preparation of SOPs** or its equivalent revision or replacement.

5.1.7.7. For Ohio VAP certification, it is required by the Ohio Administrative Code that the laboratory must seek Ohio VAP review and approval of all SOPs and Quality Manual subsequent modifications prior to implementation.

5.1.7.8. For DoD approval, all technical SOPs are reviewed for accuracy and adequacy annually and whenever method procedures change and updated as appropriate. All such reviews are documented and made available for assessment. Non-technical SOPs that are not required elements of the quality system are considered administrative SOPs and are not required to be reviewed annually.

5.2. Document Change Control

5.2.1. Changes to managed documents are reviewed and approved in the same manner as the original review. Any revision to a document requires the approval of the applicable signatories. After revisions are approved, a revision number is assigned and the previous version of the document is officially retired. Copies may be kept for audit or knowledge preservation purposes.

5.2.2. All controlled copies of the previous document are replaced with controlled copies of the revised document and the superseded copies are destroyed or archived. All affected personnel are advised that there has been a revision and any necessary training is scheduled.

5.3. Management of Change

5.3.1. The process for documenting necessary changes within the laboratory network are not typically handled using the corrective or preventive action system as outlined in section 9.0. Management of Change is a proactive approach to dealing with change to minimize the potential negative impact of systematic change in the laboratory and to ensure that each change has a positive desired outcome. This process will primarily be used for the implementation of large scale projects and information system changes as a means to apply consistent systems or procedures within the laboratory network. The request for change is submitted by the initiator and subsequently assigned to an individual or team for development and planning. The final completion of the process culminates in final approval and verification that the procedure was effectively implemented. Additional information can be found in SOP S-MN-Q-257 **Management of Change** or its equivalent revision or replacement.

6.0. EQUIPMENT AND MEASUREMENT TRACEABILITY

Each PASI facility is equipped with sufficient instrumentation and support equipment to perform the relevant analytical testing or field procedures performed by each facility. Support equipment includes chemical standards, thermometers, balances, disposable and mechanical pipettes, etc. This section details some of the procedures necessary to maintain traceability and to perform proper calibration of instrumentation and support equipment. See Attachment III for a list of equipment currently used at the (Minneapolis, Billings, Virginia and Duluth) PASI facility.

6.1. Standards and Traceability

6.1.1. Each PASI facility retains all pertinent information for standards, reagents, and chemicals to assure traceability to a national standard. This includes documentation of purchase, receipt, preparation, and use.

6.1.2. Upon receipt, all purchased standard reference materials are recorded into a standard logbook or database and assigned a unique identification number. The entries include the facility's unique identification number, the chemical name, manufacturer name, manufacturer's identification numbers, receipt date, and expiration date. Vendor's certificates of analysis for all standards, reagents, or chemicals are retained for future reference.

6.1.3. Subsequent preparations of intermediate or working solutions are also documented in a standard logbook or database. These entries include the stock standard name and lot number, the manufacturer name, the solvents used for preparation, the solvent lot number and manufacturer, the preparation steps, preparation date, expiration dates, preparer's initials, and a unique PASI identification number. This number is used in any applicable sample preparation or analysis logbook so the standard can be traced back to the standard preparation record. This process ensures traceability back to the national standard.

6.1.4. All prepared standard or reagent containers include the PASI identification number, the standard or chemical name, the date of preparation, the date of expiration, the concentration with units, and the preparer's initials. This ensures traceability back to the standard preparation logbook or database.

6.1.5. For containers that are too small to accommodate labels that list all of the above information associated with a standard, the minimum required information will be PASI standard ID, concentration, and expiration date. This assures that no standard will be used past its assigned expiration date.

6.1.6. If a second source standard is required to verify an existing calibration or spiking standard, this standard must be obtained from a different manufacturer or from a different lot unless client specific QAPP requirements state otherwise.

6.1.7. Additional information concerning standards and reagent traceability can be found in the SOP S-MN-Q-275 **Standard and Reagent Management and Traceability** or its equivalent revision or replacement.

6.2. General Analytical Instrument Calibration Procedures (Organic and Inorganic)

6.2.1. All support equipment and instrumentation are calibrated or checked before use to ensure proper functioning and verify that the laboratory's requirements are met. All calibrations are performed by, or under the supervision of, an experienced analyst at scheduled intervals against either certified standards

traceable to recognized national standards or reference standards whose values have been statistically validated.

6.2.2. Calibration standards for each parameter are chosen to establish the linear range of the instrument and must bracket the concentrations of those parameters measured in the samples. The lowest calibration standard is the lowest concentration for which quantitative data may be reported. Data reported below this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in a narrative. The highest calibration standard is the highest concentration for which quantitative data may be reported. Data reported above this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in the narrative. Any specific method requirement for number and type of calibration standards supersedes the general requirement. Instrument and method specific calibration criteria are explained within the specific analytical standard operating procedures for each facility.

- For Ohio VAP projects, samples must be reanalyzed to obtain results within the linear range unless there is insufficient sample volume for reanalysis

6.2.3. Results from all calibration standards analyzed must be included in constructing the calibration curve with the following exceptions:

6.2.3.1. The lowest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done on an individual analyte basis. The reporting limit must be adjusted to the lowest concentration included in the calibration curve;

6.2.3.2. The highest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done an individual analyte basis. The upper limit of quantitation must be adjusted to the highest concentration included in the calibration curve;

6.2.3.3. Multiple points from either the high end or the low end of the calibration curve may be excluded as long as the remaining points are contiguous in nature and the minimum number of levels remains as established by method or standard operating procedure. The reporting limit or quantitation range, whichever is appropriate, must be adjusted accordingly;

6.2.3.4. Results from a concentration level between the lowest and highest calibration levels can only be excluded from an initial calibration curve for a documentable and acceptable cause with approval from the responsible department supervisor and the local SQM/QM or their designee. An acceptable cause is defined as an obvious sample introduction issue that resulted in no response, documentation of an incorrectly prepared standard, or a documented response of a single standard that is greater than 2X the difference from the expected value of that standard. The results for all analytes are to be excluded and the point must be replaced by re-analysis. Re-analysis of this interior standard must occur within the same 12-hour tune time period for GC/MS methodologies and within 8 hours of the initial analysis of that standard for non-GC/MS methodologies. All samples analyzed prior to the re-analyzed calibration curve point must be re-analyzed after the calibration curve is completed and re-processed against the final calibration curve.

6.2.4. Instrumentation or support equipment that cannot be calibrated to specification or is otherwise defective is clearly labeled as out-of-service until it has been repaired and tested to demonstrate it meets the laboratory's specifications. All repair and maintenance activities including service calls are

documented in the maintenance log. Equipment sent off-site for calibration testing is packed and transported to prevent breakage and is in accordance with the calibration laboratory's recommendations.

6.2.5. In the event that recalibration of a piece of test equipment indicates the equipment may have been malfunctioning during the course of sample analysis, an investigation is performed. The results of the investigation along with a summary of the information reviewed are documented and maintained by the quality manager. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed. This allows for sufficient investigation and review of documentation to determine the impact on the analytical results. Instrumentation found to be consistently out of calibration is either repaired and positively verified or taken out of service and replaced.

6.2.6. Raw data records are retained to document equipment performance. Sufficient raw data is retained to reconstruct the instrument calibration and explicitly connect the continuing calibration verification to the initial calibration.

6.2.7. General Organic Calibration Procedures

6.2.7.1. Calibration standards are prepared at a minimum of five concentrations for organic analyses (unless otherwise stipulated in the method).

6.2.7.2. Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. Curves that do not meet the appropriate criteria require corrective action that may include re-running the initial calibration curve. Rounding to meet initial calibration criteria is not allowed, that is, 15.3 cannot be rounded down to meet a ≤ 15% RSD requirement. This also applies to linear and non-linear fit requirements. All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if that lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

6.2.7.3. The calibration curve is periodically verified by the analysis of a mid-level continuing calibration verification (CCV) standard during the course of sample analysis. This standard is from the same source as the initial calibration unless otherwise specified in the source method to be from an alternate source material. Rounding to meet continuing calibration criteria is not allowed. Continuing calibration verification is performed at the beginning and end of each analytical batch except if an internal standard is used, then only one verification at the beginning of the batch is needed, whenever it is expected that the analytical system may be out of calibration, if the time period for calibration has expired, or for analytical systems that have specific calibration verification requirements. This verification standard must meet acceptance criteria in order for sample analysis to proceed.

6.2.7.4. In the event that the CCV does not meet the acceptance criteria, a second CCV may be injected as part of the diagnostic evaluation and corrective action investigation. If the second CCV is acceptable, the analytical sequence may be continued. If both CCVs fail, the analytical sequence is terminated and corrective action is initiated. Sample analysis cannot begin until after documented corrective action has been completed and either two consecutive passing CCVs have been analyzed or the instrument has successfully passed a new initial calibration. All samples analyzed since the last compliant CCV are re-analyzed for methodologies utilizing external calibration.

6.2.7.4.1. For DoD labs: the lab must re-analyze CCVs and all samples analyzed since the last successful calibration verification. If re-analysis is not possible, the lab must notify the client prior to reporting data associated with a non-compliant CCV. If these data are reported, the

data must be qualified and explained in the case narrative. If the lab routinely analyzes two CCVs, then both CCVs must be evaluated. If either CCV fails, the lab must perform all required corrective actions and re-analyze all samples since the last acceptable calibration verification.

6.2.7.5. When instruments are operating unattended, autosamplers may be programmed to inject consecutive CCVs as a preventative measure against CCV failure with no corrective action. In this case, both CCVs must be evaluated to determine potential impact to the results. A summary of the decision tree and necessary documentation are listed below:

- If both CCVs meet the acceptance criteria, the analytical sequence is allowed to continue without corrective action. The 12 hour clock begins with the injection of the second CCV.
- If the first CCV does not meet the acceptance criteria and the second CCV is acceptable, the analytical sequence is continued and the results are reported.
- If the first CCV meets the acceptance criteria and the second CCV is out of control, the samples after the out of control CCV must be re-analyzed in a compliant analytical sequence.
- If both CCVs are out of control, all samples since the last acceptable CCV must be re-analyzed in a compliant analytical sequence.

6.2.7.6. Some analytical methods require that samples be bracketed by passing CCVs analyzed both before and after the samples. This is specific to each method but, as a general rule, all external calibration methods require bracketing CCVs. Most internal standard calibrations do not require bracketing CCVs.

6.2.7.7. Some analytical methods require verification based on a time interval; some methods require a frequency based on an injection interval. The type and frequency of the calibration verifications is dependent on both the analytical method and possibly on the quality program associated with the samples. The type and frequency of calibration verification will be documented in the method specific SOP employed by each laboratory.

6.2.8. General Inorganic Calibration Procedures

6.2.8.1. The instrument is initially calibrated with standards at multiple concentrations to establish the linearity of the instrument's response. A calibration blank is also included. Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. Rounding to meet initial calibration criteria is not allowed. This also applies to linear and non-linear fit requirements. The number of calibration standards used depends on the specific method criteria or customer project requirements, although normally a minimum of three standards is used.

6.2.8.2. The ICP and ICP/MS can be standardized with a zero point and a single point calibration if:

- Prior to analysis, the zero point and the single point calibration are analyzed and a linear range has been established,
- Zero point and single point calibration standards are analyzed with each batch
- A standard corresponding to the LOQ is analyzed with the batch and meets the established acceptance criteria
- The linearity is verified at the frequency established by the method or manufacturer.

6.2.8.3. All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if the lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample

results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

6.2.8.4. During the course of analysis, the calibration curve is periodically verified by the analysis of calibration verification standards (CCV). A calibration verification standard is analyzed within each analytical batch at method/program specific intervals to verify that the initial calibration is still valid. The CCV is also analyzed at the end of the analytical batch.

6.2.8.5. A calibration blank is also run with each calibration verification standard to verify the cleanliness of the system. All reported results must be bracketed by acceptable CCVs. Instrument and method specific calibration acceptance criteria are explained within the specific analytical standard operating procedures for each facility.

6.2.8.6. Interference check standards are also analyzed per method requirements and must meet acceptance criteria for metals analyses.

6.3. Support Equipment Calibration Procedures

6.3.1. All support equipment is calibrated or verified at least annually using NIST traceable references over the entire range of use. The results of calibrations or verifications must be within the specifications required or the equipment will be removed from service until repaired. The laboratory maintains records to demonstrate the correction factors applied to working thermometers.

6.3.2. On each day the equipment is used, balances, ovens, refrigerators (those used to keep samples and standards at required temperatures), freezers, and water baths are checked in the expected use range with NIST traceable references in order to ensure the equipment meets laboratory specifications and these checks are documented appropriately.

6.3.3. **Analytical Balances**

6.3.3.1. Each analytical balance is calibrated or verified at least annually by a qualified service technician. The calibration of each balance is verified each day of use with weights traceable to NIST bracketing the range of use. Calibration weights are ASTM Class 1 or other class weights that have been calibrated against a NIST standard weight and are re-certified every 5 years at a minimum against a NIST traceable reference. Some accrediting agencies may require more frequent checks. If balances are calibrated by an external agency, verification of their weights must be provided. All information pertaining to balance maintenance and calibration is recorded in the individual balance logbook and/or is maintained on file in the Quality department.

6.3.4. **Thermometers**

6.3.4.1. Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are re-certified, at a minimum, every 3 years with equipment directly traceable to NIST.

6.3.4.2. Working thermometers are compared with the reference thermometers annually according to corporate metrology procedures. Each thermometer is individually numbered and assigned a correction factor based on the NIST reference source. In addition, working thermometers are visually inspected by laboratory personnel prior to use and temperatures are documented.

6.3.4.3. Laboratory thermometer inventory and calibration data are maintained in the Quality department.

6.3.5. pH/Electrometers

6.3.5.1. The meter is calibrated before use each day, using fresh buffer solutions. See the analytical method SOP for more specific information.

6.3.6. Spectrophotometers

6.3.6.1. During use, spectrophotometer performance is checked at established frequencies in analysis sequences against initial calibration verification (ICV) and continuing calibration verification (CCV) standards.

6.3.7. Mechanical Volumetric Dispensing Devices

6.3.7.1. Mechanical volumetric dispensing devices including bottle top dispensers (those that are critical in measuring a required amount of reagent), pipettes, and burettes, excluding Class A volumetric glassware, are checked for accuracy on a quarterly basis.

6.3.7.2. Additional information regarding calibration and maintenance of laboratory support equipment can be found in SOP S-MN-Q-264 **Support Equipment** or its equivalent revision or replacement.

6.4. Instrument/Equipment Maintenance

6.4.1. The objectives of the Pace Analytical maintenance program are twofold: to establish a system of instrument care that maintains instrumentation and equipment at required levels of calibration and sensitivity, and to minimize loss of productivity due to repairs.

6.4.2. The Operations Manager and/or department manager/supervisors are responsible for providing technical leadership to evaluate new equipment, solve equipment problems, and coordinate instrument repair and maintenance. Analysts have the primary responsibility to perform routine maintenance.

6.4.3. To minimize downtime and interruption of analytical work, preventative maintenance is routinely performed on each analytical instrument. Up-to-date instructions on the use and maintenance of equipment are available to staff in the department where the equipment is used.

6.4.4. Department manager/supervisors are responsible for maintaining an adequate inventory of spare parts required to minimize equipment downtime. This inventory includes parts and supplies that are subject to frequent failure, have limited lifetimes, or cannot be obtained in a timely manner should a failure occur.

6.4.5. All major equipment and instrumentation items are uniquely identified to allow for traceability. Equipment/instrumentation is, unless otherwise stated, identified as a system and not as individual pieces. The laboratory maintains equipment records that include the following:

- The name of the equipment and its software
- The manufacturer's name, type, and serial number
- Approximate date received and date placed into service
- Current location in the laboratory
- Condition when received (new, used, etc.)
- Copy of any manufacturer's manuals or instructions
- Dates and results of calibrations and next scheduled calibration (if known)
- Details of past maintenance activities, both routine and non-routine
- Details of any damage, modification or major repairs

6.4.6. All instrument maintenance is documented in maintenance logbooks that are assigned to each particular instrument or system.

6.4.7. The maintenance log entry must include a summary of the results of that analysis and verification by the analyst that the instrument has been returned to an in-control status. In addition, each entry must include the initials of the analyst making the entry, the dates the maintenance actions were performed, and the date the entry was made in the maintenance logbook, if different from the date(s) of the maintenance.

6.4.8. Any equipment that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown to be defective, is taken out of service and clearly identified. The equipment shall not be used to analyze customer samples until it has been repaired and shown to perform satisfactorily. In the event of instrumentation failure, to avoid hold time issues, the lab may subcontract the necessary samples to another Pace lab or to an outside subcontract lab if possible.

7.0. CONTROL OF DATA

Analytical results processing, verification, and reporting are procedures employed that result in the delivery of defensible data. These processes include, but are not limited to, calculation of raw data into final concentration values, review of results for accuracy, evaluation of quality control criteria and assembly of technical reports for delivery to the data user.

All analytical data undergo a well-defined, well-documented multi-tier review process prior to being reported to the customer. This section describes procedures used by PASI for translating raw analytical data into accurate final sample reports as well as PASI data storage policies.

7.1. Analytical Results Processing

7.1.1. When analytical, field, or product testing data is generated, it is either recorded in a bound laboratory logbook (e.g., Run log or Instrument log) or copies of computer-generated printouts that are appropriately labeled and filed. These logbooks and other laboratory records are kept in accordance with each facility's Standard Operating Procedure for documentation storage and archival. If the laboratory chooses to minimize or eliminate its paper usage, these records can be kept on electronic media. In this case, the laboratory must ensure that there are sufficient redundant electronic copies so no data is lost due to unforeseen computer issues.

7.1.2. The primary analyst is responsible for initial data reduction and review. This includes confirming compliance with required methodology, verifying calculations, evaluating quality control data, noting non-conformances in logbooks or as footnotes or narratives, and uploading analytical results into the LIMS. The primary analyst must be clearly identified in all applicable logbooks, spreadsheets and LIMS fields.

7.1.3. The primary analyst then compiles the initial data package for verification. This compilation must include sufficient documentation for data review. It may include standard calibrations, chromatograms, manual integration documentation, electronic printouts, chain of custody forms, and logbook copies.

7.1.4. Some agencies or customers require different levels of data reporting. For these special levels, the primary analyst may need to compile additional project information, such as initial calibration data or extensive spectral data, before the data package proceeds to the verification step.

7.2. Data Verification

7.2.1. Data verification is the process of examining data and accepting or rejecting it based on pre-defined criteria. This review step is designed to ensure that reported data are free from calculation and transcription errors, that quality control parameters are evaluated, and that any non-conformances are properly documented.

7.2.2. Analysts performing the analysis and subsequent data reduction have primary responsibility for quality of the data produced. The primary analyst initiates the data verification process by reviewing and accepting the data, provided QC criteria have been met for the samples being reported. Data review checklists, either hardcopy or electronic, are used to document the data review process. The primary analyst is responsible for the initial input of the data into the LIMS. The primary analyst and reviewer must be clearly identified on all applicable data review checklists.

7.2.3. The completed data package is then sent to a designated qualified reviewer (this cannot be the primary analyst). The following criteria have been established to qualify someone as a data reviewer. To perform secondary data review, the reviewer must:

7.2.3.1. Have a current Demonstration of Capability (DOC) study on file and have an SOP acknowledgement form on file for the method/procedure being reviewed; or, See Note

7.2.3.2. Have a DOC on file for a similar method/technology (i.e., GC/MS) and have an SOP acknowledgment form on file for the method/procedure being reviewed; or, See Note

7.2.3.3. Supervise or manage a Department and have an SOP acknowledgment form on file for the method/procedure being reviewed; or,

7.2.3.4. Have significant background in the department/methods being reviewed through education or experience and have an SOP acknowledgment form on file for the method/procedure being reviewed.

7.2.4. **Note:** Secondary reviewer status must be approved personally by the SQM/QM or SGM/GM/AGM/OM in the event that this person has no prior experience on the specific method or general technology.

7.2.5. This reviewer provides an independent technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. This assessment involves a quality control review for use of the proper methodology and detection limits, compliance to quality control protocol and criteria, presence and completeness of required deliverables, and accuracy of calculations and data quantitation. The reviewer validates the data entered into the LIMS and documents approval of manual integrations.

7.2.6. Once the data have been technically reviewed and approved, authorization for release of the data from the analytical section is indicated by initialing and dating the data review checklist or otherwise initialing and dating the data (or designating the review of data electronically). The Operations or Project Manager examines the report for method appropriateness, detection limits and QC acceptability. Any deviations from the referenced methods are checked for documentation and validity, and QC corrective actions are reviewed for successful resolution. Alternately, final reports can be set to auto email to the client after the analytical results are final and have been run through the Data Checker program for errors. These are set up on a case-by-case basis.

7.2.7. Additional information regarding data review procedures can be found in SOP S-MN-L-132 **Data Review** or its equivalent revision or replacement, as well as in SOP S-MN-Q-214 **Manual Integration** or its equivalent revision or replacement.

7.2.8. The Data Checker program will process validated data for a given project against a set of pre-determined requirements and known chemistry relationships. The program creates a report that includes a series of warnings and errors for any requirement or condition determined to be suspect or incorrect. These warnings and error counts are displayed on the "Project Inquiry by Client" screen and on the final Data Checker reports. For projects that have any number of warnings or errors, the Data Checker report will provide a message that identifies the source and condition of the error or warning.

7.2.9. Some reports and/or data packages may be reviewed by the QM or SQM or designee based on program requirements (e.g., DoD) or client requirements. In this case a thorough review for completeness and accuracy may include a compilation of raw data and QC summaries in addition to the final report to produce a full deliverable package. In the case of DoD, 100% of all packages must have a final administrative review (to confirm that primary and secondary reviews were completed and documented and that data packages are complete) and 10% of all data packages must be reviewed by the

Quality Manager for technical completeness/accuracy. This 10% review can be done after the data packages have been submitted to the clients. See SOP S-MN-Q-271 (or equivalent replacement), **Audits and Inspections**, for full Quality department final report and raw data review requirements.

7.3. Data Reporting

7.3.1. Data for each analytical fraction pertaining to a particular PASI project number are delivered to the Project Manager for assembly into the final report. All points mentioned during technical and QC reviews are included in data qualifiers on the final report or in a separate case narrative if there is potential for data to be impacted.

7.3.2. Final reports are prepared according to the level of reporting required by the customer and can be transmitted to the customer via hardcopy or electronic deliverable. A standard PASI final report consists of the following components:

7.3.2.1. A title which designates the report as "Final Report", "Laboratory Results", "Certificate of Results", etc.;

7.3.2.2. Name and address of laboratory (or subcontracted laboratories, if used);

7.3.2.3. Phone number and name of laboratory contact to where questions can be referred;

7.3.2.4. A unique identification number for the report. The pages of the report shall be numbered and a total number of pages shall be indicated;

7.3.2.5. Name and address of customer and name of project;

7.3.2.6. Unique identification of samples analyzed as well as customer sample IDs;

7.3.2.7. Identification of any sample that did not meet acceptable sampling requirements of the relevant governing agency, such as improper sample containers, holding times missed, sample temperature, etc.;

7.3.2.8. Date and time of collection of samples, date of sample receipt by the laboratory, dates of sample preparation and analysis, and times of sample preparation and analysis when the holding time for either is 72 hours or less;

7.3.2.9. Identification of the test methods used;

7.3.2.10. Identification of sampling procedures if sampling was conducted by the laboratory;

7.3.2.11. Deviations from, additions to, or exclusions from the test methods. These can include failed quality control parameters, deviations caused by the matrix of the sample, etc., and can be shown as a case narrative or as defined footnotes to the analytical data;

7.3.2.12. Identification of whether calculations were performed on a dry or wet-weight basis;

7.3.2.13. Reporting limits used;

7.3.2.14. Final results or measurements, supported by appropriate chromatograms, charts, tables, spectra, etc.;

7.3.2.15. A signature and title, electronic or otherwise, of person accepting responsibility for the content of the report;

7.3.2.16. Date report was issued;

7.3.2.17. A statement clarifying that the results of the report relate only to the samples tested or to the samples as they were received by the laboratory;

7.3.2.18. If necessary, a statement indicating that the report must not be reproduced except in full, without the written approval of the laboratory;

7.3.2.19. Identification of all test results provided by a subcontracted laboratory or other outside source;

7.3.2.20. Identification of results obtained outside of quantitation levels.

In addition to the requirements listed above, final reports shall also contain the following items when necessary for the interpretation of results:

7.3.2.21. Deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;

7.3.2.22. Where relevant, a statement of compliance/non-compliance with requirements and/or specifications (e.g., the TNI standard);

7.3.2.23. Where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;

7.3.2.24. Where appropriate and needed, opinions and interpretations, which may include opinions on the compliance/non-compliance of the results with requirements, fulfillment of contractual requirements, recommendations on how to use the results, and guidance to be used for improvement;

7.3.3. Additional items may be required per Client QAPPs or different state regulations. Ohio VAP requires an Affidavit that must summarize if there are any exceptions to what has been reported, this includes, but is not limited to, itemizing any analytes that the laboratory is not approved for under the VAP program. Any analytes reported that are not part of a scope of accreditation or approval program must be clearly indicated on the final report and associated paperwork such as an Affidavit.

7.3.4. For DoD labs, in reference to item 7.3.2.8 listed above, both date and time of preparation and analysis are considered essential information, regardless of the length of the holding time, and shall be included as part of the laboratory report.

7.3.5. Any changes made to a final report shall be designated as "Revised" or equivalent wording. The laboratory must keep sufficient archived records of all laboratory reports and revisions. For higher levels of data deliverables, a copy of all supporting raw data is sent to the customer along with a final report of results. When possible, the PASI facility will provide electronic data deliverables (EDD) as required by contracts or upon customer request.

7.3.6. Customer data that requires transmission by telephone, telex, facsimile or other electronic means undergoes appropriate steps to preserve confidentiality.

7.3.7. The following positions are the only approved signatories for PASI final reports:

- Senior General Manager
- General Manager
- Assistant General Manager
- Senior Quality Manager
- Quality Manager

- Client Services Manager
- Project Manager
- Project Coordinator

7.4. Data Security

7.4.1. All data including electronic files, logbooks, extraction/digestion/distillation worksheets, calculations, project files and reports, and any other information used to produce the technical report are maintained secured and retrievable by the PASI facility.

7.5. Data Archiving

7.5.1. All records compiled by PASI are maintained legible and retrievable and stored secured in a suitable environment to prevent loss, damage, or deterioration by fire, flood, vermin, theft, and/or environmental deterioration. Records are retained for a minimum of five years unless superseded by federal, state, contractual, and/or accreditation requirements. These records may include, but are not limited to, customer data reports, calibration and maintenance of equipment, raw data from instrumentation, quality control documents, observations, calculations, and logbooks. These records are retained in order to provide for possible historical reconstruction including sampling, receipt, preparation, analysis, and personnel involved. TNI-related records will be made readily available to accrediting authorities. Access to archived data is documented and controlled by the SQM/QM or a designated Data Archivist.

7.5.2. Records that are computer generated have either a hard copy or electronic write protected backup copy. Hardware and software necessary for the retrieval of electronic data is maintained with the applicable records. Archived electronic records are stored protected against electronic and/or magnetic sources.

7.5.3. In the event of a change in ownership, accountability or liability, reports of analyses performed pertaining to accreditation will be maintained by the acquiring entity for a minimum of five years. In the event of bankruptcy, laboratory reports and/or records will be transferred to the customer and/or the appropriate regulatory entity upon request.

7.6. Data Disposal

7.6.1. Data that has been archived for the facility's required storage time may be disposed of in a secure manner by shredding, returning to customer, or utilizing some other means that does not jeopardize data confidentiality. Records of data disposal will be archived for a minimum of five years unless superseded by federal, contractual, and/or accreditation requirements. Data disposal includes any preliminary or final reports that are disposed.

7.6.2. For Ohio VAP labs, all documents and data prepared or acquired in connection to VAP work must be retained for a period of 10 years after the data of reporting. After 10 years, if the laboratory wishes to dispose of the records, the laboratory must notify the VAP agency by certified mail of such intent and provide the agency an opportunity to request the materials from Pace. The documents must not be disposed of until notification has been received in response to the Pace request for disposal.

8.0. QUALITY SYSTEM AUDITS AND REVIEWS

8.1. Internal Audits

8.1.1. Responsibilities

8.1.1.1. The SQM/QM is responsible for designing and/or conducting internal audits in accordance with a predetermined schedule and procedure. Since internal audits represent an independent assessment of laboratory functions, the auditor must be functionally independent from laboratory operations to ensure objectivity. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation. The SQM/QM evaluates audit observations and verifies the completion of corrective actions. In addition, a periodic corporate audit will be conducted. The corporate audits will focus on the effectiveness of the Quality System as outlined in this manual but may also include other quality programs applicable to an individual laboratory.

8.1.2. Scope and Frequency of Internal Audits

8.1.2.1. The complete internal audit process consists of the following four sections:

- Raw Data Review audits- conducted according to a schedule per local SQM/QM. A certain number of these data review audits are conducted per quarter to accomplish this yearly schedule;
- Quality System audits- considered the traditional internal audit function and includes analyst interviews to help determine whether practice matches method requirements and SOP language;
- Final Report reviews;
- Corrective Action Effectiveness Follow-up.

8.1.2.2. Internal systems audits are conducted yearly at a minimum. The scope of these audits includes evaluation of specific analytical departments or a specific quality related system as applied throughout the laboratory.

8.1.2.3. Where the identification of non-conformities or departures cast doubt on the laboratory's compliance with its own policies and procedures, the lab must ensure that the appropriate areas of activity are audited as soon as possible. Examples of system-wide elements that can be audited include:

- Quality Systems documents, such as Standard Operating Procedures, training documents, Quality Assurance Manual, and all applicable addenda
- Data records and non-technical documents
- Personnel and training files.
- General laboratory safety protocols.
- Chemical handling practices, such as labeling of reagents, solutions, and standards as well as all associated documentation.
- Documentation concerning equipment and instrumentation, calibration/maintenance records, operating manuals.
- Sample receipt and management practices.
- Analytical documentation, including any discrepancies and corrective actions.

- General procedures for data security, review, documentation, reporting, and archiving.
- Data integrity issues such as proper manual integrations.

8.1.2.4. When the operations of a specific department are evaluated, a number of additional functions are reviewed including:

- Detection limit studies
- Internal chain of custody documentation
- Documentation of standard preparations
- Quality Control limits and Control charts

8.1.2.5. Certain projects may require an internal audit to ensure laboratory conformance to site work plans, sampling and analysis plans, QAPPs, etc.

8.1.2.6. A representative number of data audits are completed annually. Findings from these data audits are handled in the same manner as those from other internal and external audits.

8.1.2.7. The laboratory, as part of their overall internal audit program, ensures that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery and reporting of potential data integrity issues are handled in a confidential manner. All investigations that result in findings of inappropriate activity are fully documented, including the source of the problem, the samples and customers affected the impact on the data, the corrective actions taken by the laboratory, and which final reports had to be re-issued. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed.

8.1.3. Internal Audit Reports and Corrective Action Plans

8.1.3.1. Additional information can be found in SOP S-MN-Q-271 **Internal and External Audits** or its equivalent revision or replacement.

8.1.3.2. A full description of the audit, including the identification of the operation audited, the date(s) on which the audit was conducted, the specific systems examined, and the observations noted are summarized in an internal audit report. Although other personnel may assist with the performance of the audit, the SQM/QM writes and issues the internal audit report identifying which audit observations are deficiencies that require corrective action.

8.1.3.3. When audit findings cast doubt on the effectiveness of the operations or on the correctness of validity of the laboratory's environmental test results, the laboratory will take timely corrective action and notify the customer in writing within three business days, if investigations show that the laboratory results may have been affected.

8.1.3.4. Once completed, the internal audit report is issued jointly to the SGM/GM/AGM/OM and the manager(s)/supervisor(s) of the audited operation at a minimum. The responsible manager(s)/supervisor(s) responds within 14 days with a proposed plan to correct all of the deficiencies cited in the audit report. The SQM/QM may grant additional time for responses to large or complex deficiencies (not to exceed 30 days). Each response must include timetables for completion of all proposed corrective actions.

8.1.3.5. The SQM/QM reviews the audit responses. If the response is accepted, the SQM/QM uses the action plan and timetable as a guideline for verifying completion of the corrective action(s). If

the SQM/QM determines that the audit response does not adequately address the correction of cited deficiencies, the response will be returned for modification.

8.1.3.6. To complete the audit process, the SQM/QM performs a re-examination of the areas where deficiencies were found to verify that all proposed corrective actions have been implemented. An audit deficiency is considered closed once implementation of the necessary corrective action has been audited and verified. This is usually within 60-90 days after implementation. If corrective action cannot be verified, the associated deficiency remains open until that action is completed.

8.2. External Audits

8.2.1. PASI laboratories are audited regularly by regulatory agencies to maintain laboratory certifications and by customers to maintain appropriate specific protocols.

8.2.2. Audit teams external to the company review the laboratory to assess the effectiveness of systems and degree of technical expertise. The SQM/QM and other QA staff host the audit team and assist in facilitation of the audit process. Generally, the auditors will prepare a formalized audit report listing deficiencies observed and follow-up requirements for the laboratory. In some cases, items of concern are discussed during a debriefing convened at the end of the on-site review process.

8.2.3. The laboratory staff and supervisors develop corrective action plans to address any deficiencies with the guidance of the SQM/QM. The SGM/GM/AGM/OM provides the necessary resources for staff to develop and implement the corrective action plans. The SQM/QM collates this information and provides a written response to the audit team. The response contains the corrective action plan and expected completion dates for each element of the plan. The SQM/QM follows-up with the laboratory staff to ensure corrective actions are implemented and that the corrective action was effective.

8.3. Quarterly Quality Reports

8.3.1. The SQM/QM is responsible for preparing a quarterly report to management summarizing the effectiveness of the laboratory Quality Systems. This status report will include:

- Overview of quality activities for the quarter
- Certification status
- Proficiency Testing study results
- SOP revision activities
- Internal audit (method/system) findings
- Manual integration audit findings (Mintminer)
- Raw Data and Final Report review findings
- MDL activities
- Other significant Quality System items

8.3.2. The Corporate Director of Quality utilizes the information from each laboratory to make decisions impacting the quality program compliance of the company as a whole. Each SGM/GM/AGM/OM utilizes the quarterly report information to make decisions impacting Quality Systems and operational systems at a local level.

8.3.3. Additional information can be found in SOP S-ALL-Q-014 **Quality System Review** or its equivalent revision or replacement.

8.4. Annual Managerial Review

8.4.1. A managerial review of Management and Quality Systems is performed on an annual basis at a minimum. This allows for assessing program effectiveness and introducing changes and/or improvements.

8.4.2. The managerial review must include the following topics of discussion:

- Suitability of quality management policies and procedures
- Manager/Supervisor reports
- Internal audit results
- Corrective and preventive actions
- External assessment results
- Proficiency testing studies
- Sample capacity and scope of work changes
- Customer feedback, including complaints
- Recommendations for improvement,
- Other relevant factors, such as quality control activities, resources, and staffing.

8.4.3. This managerial review must be documented for future reference by the SQM/QM and copies of the report are distributed to laboratory staff. Results must feed into the laboratory planning system and must include goals, objectives, and action plans for the coming year. The laboratory shall ensure that any actions identified during the review are carried out within an appropriate and agreed upon timescale.

8.5. Customer Service Reviews

8.5.1. As part of the annual managerial review listed previously, the sales staff is responsible for reporting on customer feedback, including complaints. The acquisition of this information is completed by performing surveys.

8.5.2. The sales staff continually receives customer feedback, both positive and negative, and reports this feedback to the laboratory management in order for them to evaluate and improve their management system, testing activities and customer service.

8.5.3. In addition, the labs must be willing to cooperate with customers or their representatives to clarify customer requests and to monitor the laboratory's performance in relation to the work being performed for the customers. This cooperation may include providing the customer reasonable access to relevant areas of the lab for the witnessing of tests being performed; or the preparation of samples or data deliverables to be used for verification purposes.

8.5.4. Customer service is an important aspect to Pace's overall objective of providing a quality product. Good communication should be provided to the customer's throughout projects. The lab should inform the customer of any delay or major deviations in the performance of analytical tests.

9.0. CORRECTIVE ACTION

Additional information can be found in SOP S-MN-Q-262 **Corrective and Preventive Actions** or its equivalent revision or replacement.

During the process of sample handling, preparation, and analysis, or during review of quality control records, or during reviews of non-technical portions of the lab, certain occurrences may warrant the necessity of corrective actions. These occurrences may take the form of analyst errors, deficiencies in quality control, method deviations, or other unusual circumstances. The Quality System of PASI provides systematic procedures for the documentation, monitoring, completion of corrective actions, and follow-up verification of the effectiveness of these corrective actions. This can be done using PASI's LabTrack system or other system that lists among at a minimum, the deficiency by issue number, the deficiency source, responsible party, root cause, resolution, due date, and date resolved.

9.1. Corrective Action Documentation

9.1.1. The following items are examples of sources of laboratory deviations or non-conformances that warrant some form of documented corrective action:

- Internal Laboratory Non-Conformance Trends
- PE/PT Sample Results
- Internal and External Audits
- Data or Records Review (including non-technical records)
- Client Complaints
- Client Inquiries
- Holding Time violations

9.1.2. Documentation of corrective actions may be in the form of a comment or footnote on the final report that explains the deficiency (e.g., matrix spike recoveries outside of acceptance criteria) or it may be a more formal documentation (either paper system or computerized spreadsheet). This depends on the extent of the deficiency, the impact on the data, and the method or customer requirements for documentation.

9.1.3. The person who discovers the deficiency or non-conformance initiates the corrective action documentation on the Non-Conformance Corrective/ Preventive Action report and/or LabTrack. The documentation must include the affected projects and sample numbers, the name of the applicable Project Manager, the customer name, and the sample matrix involved. The person initiating the corrective action documentation must also list the known causes of the deficiency or non-conformance as well as any corrective/preventative actions that they have taken. Preventive actions must be taken in order to prevent or minimize the occurrence of the situation.

9.1.4. In the event that the laboratory is unable to determine the cause, laboratory personnel and management staff will start a root cause analysis by going through an investigative process. During this process, the following general steps must be taken into account: defining the non-conformance, assigning responsibilities, determining if the condition is significant, and investigating the root cause of the nonconformance. General non-conformance investigative techniques follow the path of the sample through the process looking at each individual step in detail. The root cause must be documented within LabTrack or on the Corrective/Preventive Action Report.

9.1.5. After all the documentation is completed, the routing of the Corrective/Preventive Action Report and /or LabTrack will continue from the person initiating the corrective action, to their immediate supervisor or the applicable Project Manager and finally to the SQM/QM, if applicable, who may be responsible for final review and signoff of corrective/preventive actions.

9.1.6. In the event that analytical testing or results do not conform to documented laboratory policies or procedures, customer requirements, or standard specifications, the laboratory shall investigate the significance of the non-conformance and document appropriate corrective actions. The proper level of laboratory management will review any departure from these requirements for technical suitability. These departures are permitted only with the approval of the SGM/GM/AGM/OM or the SQM/QM. Where necessary, Project Management will notify the customer of the situation and will advise of any ramifications to data quality (with the possibility of work being recalled). The procedures for handling non-conforming work are detailed in SOP S-MN-Q-262 **Corrective and Preventive Actions** or its equivalent revision or replacement.

9.2. Corrective Action Completion

9.2.1. Internal Laboratory Non-Conformance Trends

9.2.1.1. There are several types of non-conformance trends that may occur in the laboratory that would require the initiation of a corrective action report. Laboratories may choose to initiate a corrective action for all instances of one or more of these categories if they so choose, however the intent is that each of these would be handled according to its severity; one time instances could be handled with a footnote or qualifier whereas a systemic problem with any of these categories may require an official corrective action process. These categories, as defined in the Corrective Action SOP are as follows:

- Login error
- Preparation Error
- Contamination
- Calibration Failure
- Internal Standard Failure
- LCS Failure
- Laboratory accident
- Spike Failure
- Instrument Failure
- Final Reporting error

9.2.2. PE/PT Sample Results

9.2.2.1. Any PT result assessed as "not acceptable" requires an investigation and applicable corrective actions. The operational staff is made aware of the PT failures and they are responsible for reviewing the applicable raw data and calibrations and list possible causes for error. The SQM/QM reviews their findings and initiates another external PT sample or an internal PT sample to try and correct the previous failure. Replacement PT results must be monitored by the SQM/QM and reported to the applicable regulatory authorities.

9.2.3. Internal and External Audits

9.2.3.1. The SQM/QM is responsible for documenting all audit findings and their corrective actions. This documentation must include the initial finding, the persons responsible for the

corrective action, the due date for responding to the auditing body, the root cause of the finding, and the corrective actions needed for resolution. The SQM/QM is also responsible for providing any back-up documentation used to demonstrate that a corrective action has been completed.

9.2.4. Data Review

9.2.4.1. In the course of performing primary and secondary review of data or in the case of raw data reviews (e.g., by the SQM/QM), errors may be found which require corrective actions. Any finding that affects the quality of the data requires some form of corrective action, which may include revising and re-issuing of final reports.

9.2.5. Client Complaints

9.2.5.1. Project Managers are responsible for issuing corrective action forms, when warranted, for customer complaints. As with other corrective actions, the possible causes of the problem are listed and the form is passed to the appropriate analyst or supervisor for investigation. After potential corrective actions have been determined, the Project Manager reviews the corrective action form to ensure all customer needs or concerns are being adequately addressed.

9.2.6. Client Inquiries

9.2.6.1. When an error on the customer report is discovered, the Project Manager is responsible for initiating a formal corrective action form that describes the failure (e.g., incorrect analysis reported, reporting units are incorrect, or reporting limits do not meet objectives). The Project Manager is also responsible for revising the final report if necessary and submitting it to the customer.

9.2.7. Holding Time Violations

9.2.7.1. In the event that a holding time has been missed, the analyst or supervisor must complete a formal corrective action form. The Project Manager and the SQM/QM must be made aware of all holding time violations.

9.2.7.2. The Project Manager must contact the customer in order that appropriate decisions are made regarding the hold time excursion and the ultimate resolution is then documented and included in the customer project file.

9.3. Preventive Action Documentation

9.3.1. Pace laboratories can take advantage of several available information sources in order to identify needed improvements in all of their systems including technical, managerial, and quality. These sources may include:

- Management Continuous Improvement Plan (CIP) metrics which are used by all production departments within Pace. When groups compare performance across the company, ways to improve systems may be discovered. These improvements can be made within a department or laboratory-wide.
- Annual managerial reviews- part of this TNI-required and NVLAP-required review is to look at all processes and procedures used by the laboratory over the past year and to determine ways to improve these processes in the future.
- Quality systems reviews- any frequent checks of quality systems (monthly logbook reviews, etc.) can uncover issues that can be corrected or adjusted before they become a larger issue.

9.3.2. When improvement opportunities are identified or if preventive action is required, the laboratory can develop, implement, and monitor preventive action plans.

10.0. GLOSSARY

The source of some of the definitions is indicated previous to the actual definition (e.g., TNI, DoD).

Terms and Definitions	
3P Program	The Pace Analytical continuous improvement program that focuses on Process, Productivity, and Performance. Best Practices are identified that can be used by all PASI labs.
Acceptance Criteria	TNI and DoD- Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	TNI and DoD- The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.
Accreditation Body	DoD- Authoritative body that performs accreditation.
Accuracy	TNI and DoD- The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Aliquot	DoD- A discrete, measured, representative portion of a sample taken for analysis.
Analysis	A combination of sample preparation and instrument determination.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analysis Sequence	A compilation of all samples, standards and quality control samples run during a specific amount of time on a particular instrument in the order they are analyzed.
Analyst	TNI and DoD- The designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.
Analyte	DoD- The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family and are analyzed together.
Analytical Uncertainty	TNI- A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Assessment	TNI - The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its system to defined criteria (to the standards and requirements of laboratory accreditation). DoD- The evaluation process used to measure the performance or effectiveness of a system and its elements against specific criteria. Note: In this standard (DoD), assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection, or surveillance.
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	DoD -A process in which a sample is converted to free atoms.

Audit	TNI- A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. DoD- A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.
Batch	TNI and DoD- Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed 20 samples. South Carolina- same definition as TNI except 24 hours should be changed to 8 hours.
Bias	TNI- The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	TNI and DoD- A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.
Blind Sample	DoD-A sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.
Calibration	TNI and DoD- A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve	TNI- The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. DoD- The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	DoD- A defined technical procedure for performing a calibration.
Calibration Range	DoD- The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	TNI- A substance or reference material used for calibration. DoD- A substance or reference material used to calibrate an instrument.
Certified Reference Material (CRM)	TNI- Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. DoD- A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body.
Chain of Custody	DoD- An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of custody Form (COC)	TNI and DoD- Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and type of containers; the mode of collection, the collector, time of collection; preservation; and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	DoD- Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	TNI and DoD- Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second-column confirmation; alternate wavelength; derivatization; mass spectral interpretation; alternative detectors; or additional cleanup procedures.
Conformance	DoD- An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.

Congener	DoD- A member of a class of related chemical compounds (e.g., PCBs, PCDDs).
Consensus Standard	DoD- A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.
Continuing Calibration Verification	DoD- The verification of the initial calibration. Required prior to sample analysis and at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a CVS in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.
Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Correction	DoD- Action taken to eliminate a detected non-conformity.
Corrective Action	DoD- The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence. A root cause analysis may not be necessary in all cases.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Customer	DoD- Any individual or organization for which products or services are furnished or work performed in response to defined requirements and expectations.

Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	TNI- The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more usable form.
Definitive Data	DoD- Analytical data of known quantity and quality. The levels of data quality on precision and bias meet the requirements for the decision to be made. Data that is suitable for final decision-making.
Demonstration of Capability	TNI- A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. DoD- A procedure to establish the ability of the analyst to generate analytical results by a specific method that meet measurement quality objectives (e.g., for precision and bias).
Detection Limit (DL)	DoD- The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration at the 99% confidence. At the DL, the false positive rate (Type 1 error) is 1%. A DL may be used as the lowest concentration for reliably reporting a detection of a specific analyte in a specific matrix with a specific method with 99% confidence.
Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).
Digestion	DoD- A process in which a sample is treated (usually in conjunction with heat and acid) to convert the sample to a more easily measured form.
Document Control	DoD- The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.
Documents	DoD- Written components of the laboratory management system (e.g., policies, procedures, and instructions).
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (also known as Replicate or Laboratory Duplicate)	DoD- The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g., PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	DoD- A solvent used to carry the components of a mixture through a stationary phase.
Elute	DoD- To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	DoD- A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	DoD- Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.

Environmental Monitoring	DoD- The process of measuring or collecting environmental data.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.
Facility	A distinct location within the company that has unique certifications, personnel and waste disposal identifications.
False Negative	DoD- A result that fails to identify (detect) an analyte or reporting an analyte to be present at or below a level of interest when the analyte is actually above the level of interest.
False Positive	DoD- A result that erroneously identifies (detects) an analyte or reporting an analyte to be present above a level of interest when the analyte is actually present at or below the level of interest.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and space to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	TNI- Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.
Finding	TNI- An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement. DoD- An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive, negative, or neutral and is normally accompanied by specific examples of the observed condition. The finding must be linked to a specific requirement (e.g., this standard (DoD QSM), ISO requirements, analytical methods, contract specifications, or laboratory management systems requirements).

Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	TNI- The maximum time that can elapse between two specified activities. 40 CFR Part 136- The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised. For sample prep purposes, hold times are calculated using the time of the start of the preparation procedure. DoD- The maximum time that may elapse from the time of sampling to the time of preparation or analysis, or from preparation to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	DoD- One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member. For instance, methanol, ethanol, propanol, butanol, etc., form a homologous series.
Improper Actions	DoD- Intentional or unintentional deviations from contract-specified or method-specified analytical practices that have not been authorized by the customer (e.g., DoD or DOE).
Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP-AES that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.

Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.
Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Blank (ICB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method. This blank is specifically run in conjunction with the Initial Calibration Verification (ICV) where applicable.
Initial Calibration Verification (ICV)	DoD- Verifies the initial calibration with a standard obtained or prepared from a source independent of the source of the initial calibration standards to avoid potential bias of the initial calibration.
Inspection	DoD- An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic.
Instrument Blank	DoD- A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Instrument Detection Limits (IDLs)	Limits determined by analyzing a series of reagent blank analyses to obtain a calculated concentration. IDLs are determined by calculating the average of the standard deviations of three runs on three non-consecutive days from the analysis of a reagent blank solution with seven consecutive measurements per day.
Interference, spectral	DoD- Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	DoD- Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standards	TNI and DoD- A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	DoD- The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties. For example, hexane (C6H14) could be n-hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.
Laboratory	DoD- A body that calibrates and/or tests.

Laboratory Control Sample (LCS)	TNI and DoD- (however named, such as laboratory fortified blank (LFB), spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of all or a portion of the measurement system.
Laboratory Duplicate	DoD- Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	A computer system that is used to maintain all sample information from sample receipt, through preparation and analysis and including sample report generation.
LabTrack	Database used by Pace Analytical to store and track corrective actions and other laboratory issues.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Legal Chain-of-Custody Protocols	TNI- Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain-of-Custody (COC) Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.
Limit(s) of Detection (LOD)	TNI- A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. DoD- The smallest concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate is 1%.
Limit(s) of Quantitation (LOQ)	TNI- The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. DoD- The smallest concentration that produces a quantitative result with known and recorded precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard and within the calibration range.
Linear Dynamic Range	DoD- Concentration range where the instrument provides a linear response.
Liquid chromatography/ tandem mass spectrometry (LC/MS/MS)	Instrumentation that combines the physical separation techniques of liquid chromatography with the mass analysis capabilities of mass spectrometry.
Lot	A quantity of bulk material of similar composition processed or manufactured at the same time.
Management	DoD- Those individuals directly responsible and accountable for planning, implementing, and assessing work.

Management System	DoD- System to establish policy and objectives and to achieve those objectives.
Manager (however named)	DoD- The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	TNI and DoD- The substrate of a test sample.
Matrix Duplicate	TNI- A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	TNI- A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. DoD- A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	TNI and DoD- A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
Measurement Performance Criteria (MPC)	Criteria that may be general (such as completion of all tests) or specific (such as QC method acceptance limits) that are used by a project to judge whether a laboratory can perform a specified activity to the defined criteria.
Measurement System	TNI and DoD- A test method, as implemented at a particular laboratory, and which includes the equipment used to perform the sample preparation, test and the operator(s).
Measurement Uncertainty	An estimate of the error in a measurement often stated as a range of values that contain the true value, within a certain confidence level. The uncertainty generally includes many components which may be evaluated from experimental standard deviations based on repeated observations or by standard deviations evaluated from assumed probability distributions based on experience or other information. For DoD/DOE, a laboratory's Analytical Uncertainty (such as use of LCS control limits) can be reported as the minimum uncertainty.
Method	TNI- A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.
Method Blank	TNI and DoD- A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit (MDL)	DoD- One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	DoD- A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
MintMiner	Program used by Pace Analytical to review large amounts of chromatographic data to monitor for errors or data integrity issues.
Mobile Laboratory	TNI- A portable enclosed structure with necessary and appropriate accommodation and environmental conditions for a laboratory, within which testing is performed by analysts. Examples include but are not limited to trailers, vans, and skid-mounted structures configured to house testing equipment and personnel.
National Institute of Standards and Technology (NIST)	TNI- A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	DoD- Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.
Nonconformance	DoD- An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Operator Aid	A technical posting (such as poster, operating manual, or notepad) that assists workers in performing routine tasks. All operator aids must be controlled documents (i.e., a part of the laboratory management system).
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	DoD- Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Post-Digestion Spike	A sample prepared for metals analyses that has analytes spike added to determine if matrix effects may be a factor in the results.
Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.

Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	TNI and DoD- The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	TNI- Any conditions under which a sample must be kept in order to maintain chemical, physical, and/or biological integrity prior to analysis. DoD- Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.
Procedure	TNI- A specified way to carry out an activity or process. Procedures can be documented or not.
Proficiency Testing	TNI and DoD- A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.
Proficiency Testing Program	TNI and DoD- The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.
Proficiency Testing Sample (PT)	TNI- A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria. DoD- A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria.
Protocol	TNI and DoD- A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed.
Qualitative Analysis	DoD- Analysis designed to identify the components of a substance or mixture.
Quality Assurance (QA)	TNI- An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client. DoD- An integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.
Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	DoD- A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

Quality Control (QC)	TNI- The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality. DoD- The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of the users.
Quality Control Sample (QCS)	TNI- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. DoD- A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking.
Quality Manual	TNI and DoD- A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	TNI and DoD- A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.

Quality System Matrix	TNI and DoD- These matrix definitions are to be used for purposes of batch and quality control requirements: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin. • **Chemical Waste**: A product or by-product of an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	DoD- The range of values (concentrations) in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard. The quantitation range lies within the calibration range.
Quantitative Analysis	Analysis designed to determine the amounts or proportions of the components of a substance.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	TNI- The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. DoD- Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.
Reagent Blank (method reagent blank)	DoD- A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Records	DoD- The output of implementing and following management system documents (e.g., test data in electronic or hand-written forms, files, and logbooks).
Reference Material	TNI- Material or substance one or more of whose property values are sufficiently homogenized and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. DoD- A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.
Reference Standard	TNI- Standard used for the calibration of working measurement standards in a given organization or at a given location. DoD- A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.
Reference Toxicant	DoD- The toxicant used in performing toxicity tests to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the test correctly and obtain consistent results.
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e., statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. DoD- A customer-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (or otherwise named)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	DoD- Denotes a mandatory specification; often designated by the term "shall".
Retention Time	DoD- The time between sample injection and the appearance of a solute peak at the detector.
Sample	DoD- Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by Pace Analytical sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).

Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a Chain of custody Form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	TNI- Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selective Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector.
Selectivity	TNI- The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. DoD- The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances.
Sensitivity	TNI and DoD- The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Serial Dilution	The stepwise dilution of a substance in a solution.
Shall	DoD- Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should	DoD- Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio (S/N)	DoD- S/N is a measure of signal strength relative to background noise. The signal carries information about the analyte, while noise is made up of extraneous information that is unwanted because it degrades the accuracy and precision of an analysis and also places a lower limit on the amount of analyte that can be detected. The average strength of the noise of most measurements is constant and independent of the magnitude of the signal. Thus, as the quantity being measured (producing the signal) decreases in magnitude, S/N decreases and the effect of the noise on the relative error of a measurement increases.
Spike	DoD- A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	TNI and DoD- The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Standard (Chemical)	DoD- Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	DoD- A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	TNI- A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. DoD- A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.
Standard Reference Material (SRM)	DoD- A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.
Storage Blank	DoD- A sample of analyte-free media prepared by the laboratory and retained in the sample storage area of the laboratory. A storage blank is used to record contamination attributable to sample storage at the laboratory.
Supervisor	DoD- The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	DoD- A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	DoD- Analytes or chemicals of primary concern, identified by the customer on a project-specific basis.
Technical Director	DoD- Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Technology	TNI- A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Test	DoD- A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	DoD- A definitive procedure that determines one or more characteristics of a given substance or product.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.
Traceability	TNI- The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. DoD- The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	DoD- A check and/or adjustment of instrument performance for mass spectrometry as required by the method.
Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty Measurement	The parameter associated with the result of a measurement that characterized the dispersion of the values that could be reasonably attributed to the measurand (i.e. the concentration of an analyte).
Unethical actions	DoD- Deliberate falsification of analytical or quality control results, where failed method or contractual requirements are made to appear acceptable.
Unregulated Contaminate Monitoring Rule (UCMR)	EPA program to monitor unregulated contaminates in drinking water.

Validation	DoD- The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	TNI and DoD- Confirmation by examination and objective evidence that specified requirements have been met. Note: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).
Work Cell	DoD- A well-defined group of analysts that together perform the method analysis. The members of the group and their specific functions within the work cell must be fully documented.

11.0. REFERENCES

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12.0. REVISIONS

The PASI Corporate Quality Office files both a paper copy and electronic version of a Microsoft Word document with tracked changes detailing all revisions made to the previous version of the Quality Assurance Manual. This document is available upon request. All revisions are summarized in the table below.

Document Number	Reason for Change	Date
Quality Assurance Manual 17.0	Section 1.77: Added HRMS to the breakdown of the laboratory department Section 2.6.5: Updated facility codes. Section 2.10: Added exception to Air canisters for sample retention Section 6.2.3.4: Reworded language regarding calibrations. Section 6.2.7.8: Removed OhioVAP as it is no longer pertain to the lab Section 6.3.7.1: Removed last sentence about syringes. Section 6.4.8: Added sentence about instrumentation failure. Section 7.2.6: Added language regarding auto email function. Section 7.5.1.1: Added red letter section for special data retention requirements. Section 9.2.7.2: Removed sentence regarding hold time reporting by QMs. Section 10: Updated DoD definitions per DoD/DOE QSM, revision 5.0. Also added definitions for LC/MS/MS and UCMR. Section 11: Revised DoD reference and added UCMR3 reference. Attachment VIII: added several drinking water methods and added note 4 regarding hexavalent holding time and preservation. Section 4.0: included a statement that refers the reader to the SOPs for detail Section 4.2.9: clarified MS cannot be used in place of the LCS for Ohio VAP project Section 4.3.8 and 4.4.1: indicated that the results are optional for Ohio VAP project Section 4.5.1.3: added that TO-15 surrogates are not evaluated for Ohio VAP samples 6.2.2: added exception for Ohio VAP sample Section 7.3.3: added Ohio VAP requirement for affidavit Attachment IIA-IIC: updated to current version Attachment III: updated to contain the most current information Attachment IVB: updated to new address floor plan Attachment V: updated list of SOPs to reflect the current use Attachment VI: updated expiration date Attachment VIII: added Additional Volume for MS/MSD column Included Pace-Virginia and Duluth information for a regional quality manual throughout the document.	13May2014
Quality Assurance Manual 17.1	Section 4.12.1: Changed NIST PT providers to TNI and state regulatory Attachment V-VI: Separated Virginia and Duluth to have its own individual tables Attachment II-III, V-VI: Updated to most current version Attachment IVC- Removed Duluth	18June2014
Quality Assurance Manual 17.2	Section 4.2.4: Added note that this method is not acceptable for South Carolina Section 4.2.6: Added note that this method is not acceptable for South Carolina Section 4.2.7: Added note that this method is not acceptable for South Carolina	22 Dec 2014

ATTACHMENT I- QUALITY CONTROL CALCULATIONS

PERCENT RECOVERY (%REC)

$$\%REC = \frac{(MSConc - SampleConc)}{TrueValue} * 100$$

NOTE: The SampleConc is zero (0) for theLCS and Surrogate Calculations

PERCENT DIFFERENCE (%D)

$$\%D = \frac{MeasuredValue - TrueValue}{TrueValue} * 100$$

where:
TrueValue = Amount spiked (can also be the $\overline{CF}$ or $\overline{RF}$ of the ICAL Standards)
Measured Value = Amount measured (can also be the CF or RF of the CCV)

PERCENT DRIFT

$$\%Drift = \frac{CalculatedConcentration - TheoreticalConcentration}{TheoreticalConcentrtion} * 100$$

RELATIVE PERCENT DIFFERENCE (RPD)

$$RPD = \frac{|(R1 - R2)|}{(R1 + R2)/2} * 100$$

where:
R1 = Result Sample 1
R2 = Result Sample 2

CORRELATION COEFFICIENT (R)

$$CorrCoeff = \frac{\sum_{i=1}^{N} W_i * (X_i - \overline{X}) * (Y_i - \overline{Y})}{\sqrt{\left(\sum_{i=1}^{N} W_i * (X_i - \overline{X})^2\right) * \left(\sum_{i=1}^{N} W_i * (Y_i - \overline{Y})^2\right)}}$$

With:

N	Number of standard samples involved in the calibration
i	Index for standard samples
Wi	Weight factor of the standard sample no. i
Xi	X-value of the standard sample no. i
X(bar)	Average value of all x-values
Yi	Y-value of the standard sample no. i
Y(bar)	Average value of all y-values

ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

STANDARD DEVIATION (S)

$$S = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{(n-1)}}$$

where:
n = number of data points
X_i = individual data point
$\overline{X}$ = average of all data points

AVERAGE $(\overline{X})$

$$\overline{X} = \frac{\sum_{n=1}^{i} X_i}{n}$$

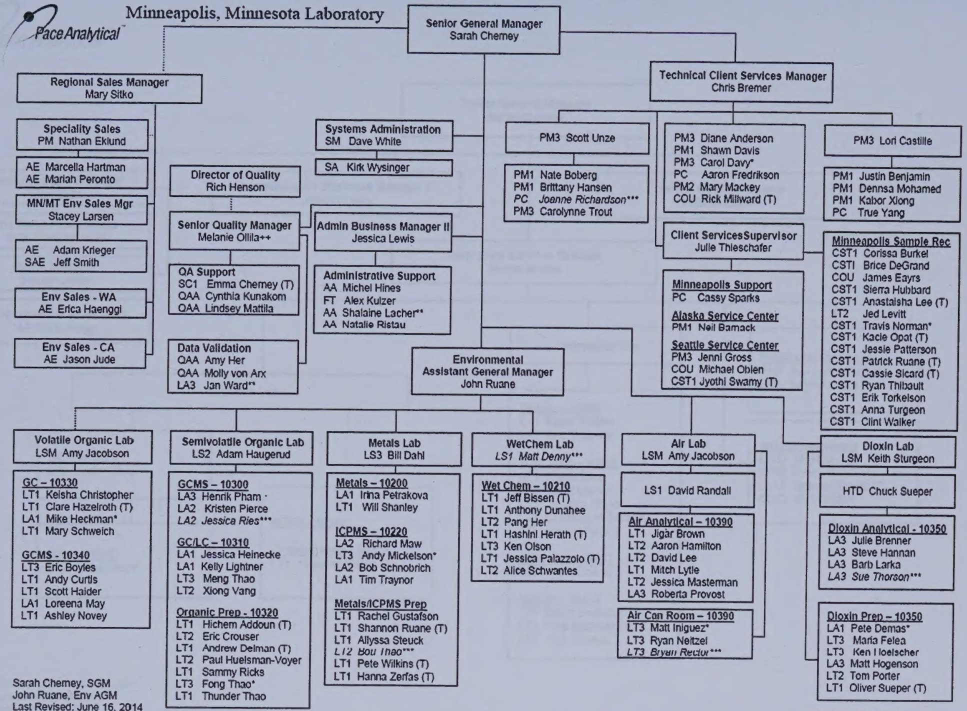
where:
n = number of data points
X_i = individual data point

RELATIVE STANDARD DEVIATION (RSD)

$$RSD = \frac{S}{\overline{X}} * 100$$

where:
S = Standard Deviation of the data points
$\overline{X}$ = average of all data points

ATTACHMENT IIA- MINNEAPOLIS LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)


Pace Analytical
Minneapolis, Minnesota Laboratory
Senior General Manager
Sarah Chemey
Regional Sales Manager
Mary Sitko
Speciality Sales
PM Nathan Eklund
AE Marcella Hartman
AE Mariah Peronto
MN/MT Env Sales Mgr
Stacey Larsen
AE Adam Krieger
SAE Jeff Smith
Env Sales - WA
AE Erica Haenggi
Env Sales - CA
AE Jason Jude
Director of Quality
Rich Henson
Senior Quality Manager
Melanie Ollila++
QA Support
SC1 Emma Chemey (T)
QAA Cynthia Kunakom
QAA Lindsey Mattila
Data Validation
QAA Amy Her
QAA Molly von Arx
LA3 Jan Ward**
Systems Administration
SM Dave White
SA Kirk Wysinger
Admin Business Manager II
Jessica Lewis
Administrative Support
AA Michel Hines
FT Alex Kulzer
AA Shalaine Lacher**
AA Natalie Ristau
Environmental
Assistant General Manager
John Ruane
Technical Client Services Manager
Chris Bremer
PM3 Scott Unze
PM1 Nate Boberg
PM1 Brittany Hansen
PC Joanne Richardson***
PM3 Carolynne Trout
PM3 Diane Anderson
PM1 Shawn Davis
PM3 Carol Davy*
PC Aaron Fredrikson
PM2 Mary Mackey
COU Rick Millward (T)
PM3 Lori Castille
PM1 Justin Benjamin
PM1 Dennsa Mohamed
PM1 Kabor Xiong
PC True Yang
Client ServicesSupervisor
Julie Thieschafer
Minneapolis Support
PC Cassy Sparks
Alaska Service Center
PM1 Neil Barnack
Seattle Service Center
PM3 Jenni Gross
COU Michael Oblen
CST1 Jyothi Swamy (T)
Minneapolis Sample Rec
CST1 Corissa Burkel
CSTI Brice DeGrand
COU James Eayrs
CST1 Sierra Hubbard
CST1 Anastaisha Lee (T)
LT2 Jed Levitt
CST1 Travis Norman*
CST1 Kacie Opat (T)
CST1 Jessie Patterson
CST1 Patrick Ruane (T)
CST1 Cassie Sicard (T)
CST1 Ryan Thibault
CST1 Erik Torkelson
CST1 Anna Turgeon
CST1 Clint Walker
Volatile Organic Lab
LSM Amy Jacobson
GC – 10330
LT1 Keisha Christopher
LT1 Clare Hazelroth (T)
LA1 Mike Heckman*
LT1 Mary Schweich
GCMS - 10340
LT3 Eric Boyles
LT1 Andy Curtis
LT1 Scott Haider
LA1 Loreena May
LT1 Ashley Novey
Semivolatile Organic Lab
LS2 Adam Haugerud
GCMS – 10300
LA3 Henrik Pham
LA2 Kristen Pierce
LA2 Jessica Ries***
GC/LC – 10310
LA1 Jessica Heinecke
LA1 Kelly Lightner
LT3 Meng Thao
LT2 Xiong Vang
Organic Prep - 10320
LT1 Hichem Addoun (T)
LT2 Eric Crouser
LT1 Andrew Delman (T)
LT2 Paul Huelsman-Voyer
LT1 Sammy Ricks
LT3 Fong Thao*
LT1 Thunder Thao
Metals Lab
LS3 Bill Dahl
Metals – 10200
LA1 Irina Petrakova
LT1 Will Shanley
ICPMS – 10220
LA2 Richard Maw
LT3 Andy Mickelson*
LA2 Bob Schnobrich
LA1 Tim Traynor
Metals/ICPMS Prep
LT1 Rachel Gustafson
LT1 Shannon Ruane (T)
LT1 Allyssa Steuck
LT2 Bou Thao***
LT1 Pete Wilkins (T)
LT1 Hanna Zerfas (T)
WetChem Lab
LS1 Matt Denny***
Wet Chem – 10210
LT1 Jeff Bissen (T)
LT1 Anthony Dunahee
LT2 Pang Her
LT1 Hashini Herath (T)
LT3 Ken Olson
LT1 Jessica Palazzolo (T)
LT2 Alice Schwantes
Air Lab
LSM Amy Jacobson
LS1 David Randall
Air Analytical – 10390
LT1 Jigar Brown
LT2 Aaron Hamilton
LT2 David Lee
LT1 Mitch Lytle
LT2 Jessica Masterman
LA3 Roberta Provost
Air Can Room – 10390
LT3 Matt Iniguez*
LT3 Ryan Neitzel
LT3 Bryan Rector***
Dioxin Lab
LSM Keith Sturgeon
HTD Chuck Sueper
Dioxin Analytical - 10350
LA3 Julie Brenner
LA3 Steve Hannan
LA3 Barb Larka
LA3 Sue Thorson***
Dioxin Prep – 10350
LA1 Pete Demas*
LT3 Maria Felea
LT3 Ken Hoelscher
LA3 Matt Hogenson
LT2 Tom Porter
LT1 Oliver Sueper (T)

Sarah Chemey, SGM
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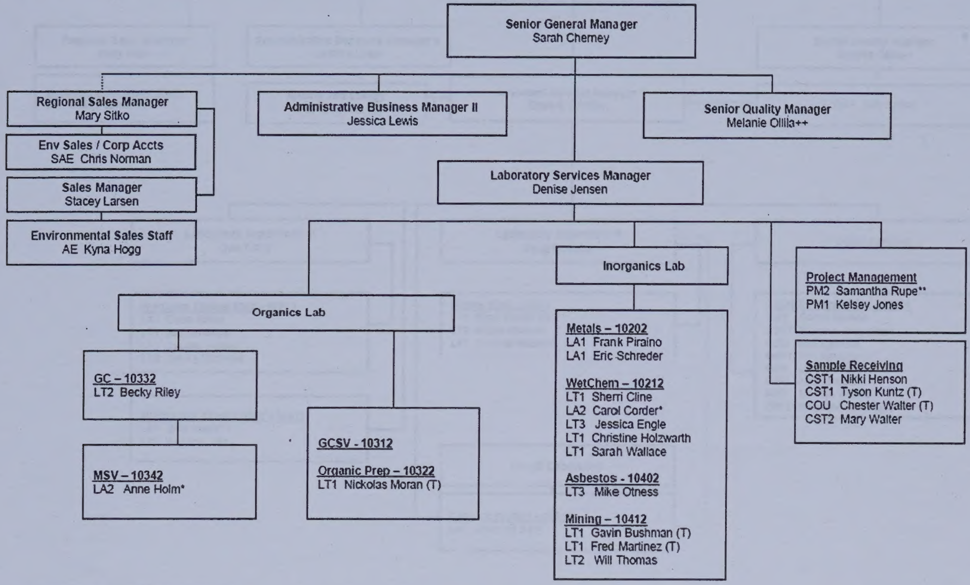
(T) Temporary Employee

++MN Region Safety Officer
**Safety Officer/Waste Coordinator
***Safety Committee Member

ATTACHMENT IIB- MONTANA LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)


Senior General Manager
Sarah Chemey
Regional Sales Manager
Mary Sitko
Env Sales / Corp Accts
SAE Chris Norman
Sales Manager
Stacey Larsen
Environmental Sales Staff
AE Kyna Hogg
Administrative Business Manager II
Jessica Lewis
Senior Quality Manager
Melanie Ollila++
Laboratory Services Manager
Denise Jensen
Organics Lab
GC – 10332
LT2 Becky Riley
MSV – 10342
LA2 Anne Holm*
GCSV - 10312
Organic Prep – 10322
LT1 Nickolas Moran (T)
Inorganics Lab
Metals – 10202
LA1 Frank Piraino
LA1 Eric Schreder
WetChem – 10212
LT1 Sherri Cline
LA2 Carol Corder*
LT3 Jessica Engle
LT1 Christine Holzwarth
LT1 Sarah Wallace
Asbestos - 10402
LT3 Mike Otness
Mining – 10412
LT1 Gavin Bushman (T)
LT1 Fred Martinez (T)
LT2 Will Thomas
Project Management
PM2 Samantha Rupe**
PM1 Kelsey Jones
Sample Receiving
CST1 Nikki Henson
CST1 Tyson Kuntz (T)
COU Chester Walter (T)
CST2 Mary Walter

Sarah Chemey, General Manager
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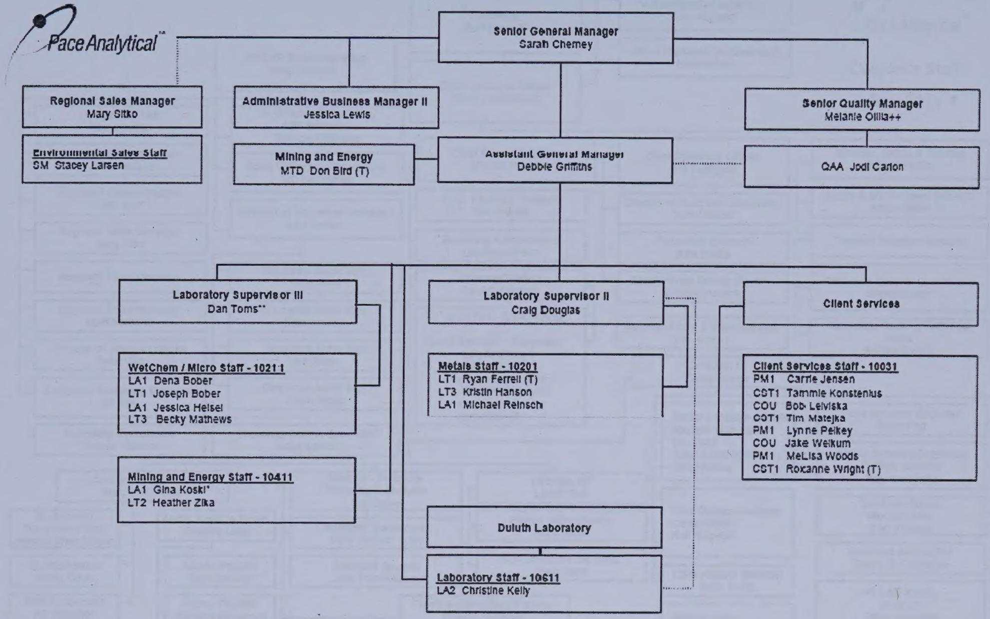
*Lead Analyst/Technician
**Safety Officer
(T) Temporary Employee

Billings, Montana Laboratory

ATTACHMENT IIC- VIRGINIA AND DULUTH LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)


Pace Analytical™
Senior General Manager
Sarah Chemey
Regional Sales Manager
Mary Sitko
Administrative Business Manager II
Jessica Lewis
Senior Quality Manager
Melanie Ollila++
Environmental Sales Staff
SM Stacey Larsen
Mining and Energy
MTD Don Bird (T)
Assistant General Manager
Debbie Griffiths
QAA Jodi Carlon
Laboratory Supervisor III
Dan Toms**
Laboratory Supervisor II
Craig Douglas
Client Services
WetChem / Micro Staff - 10211
LA1 Dena Bober
LT1 Joseph Bober
LA1 Jessica Heisel
LT3 Becky Mathews
Metals Staff - 10201
LT1 Ryan Ferrell (T)
LT3 Kristin Hanson
LA1 Michael Reinsch
Client Services Staff - 10031
PM1 Carrie Jensen
CST1 Tammie Konstenius
COU Bob Leiviska
CST1 Tim Matejka
PM1 Lynne Pelkey
COU Jake Weikum
PM1 MeLisa Woods
CST1 Roxanne Wright (T)
Mining and Energy Staff - 10411
LA1 Gina Koski*
LT2 Heather Zika
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Laboratory Staff - 10611
LA2 Christine Kelly

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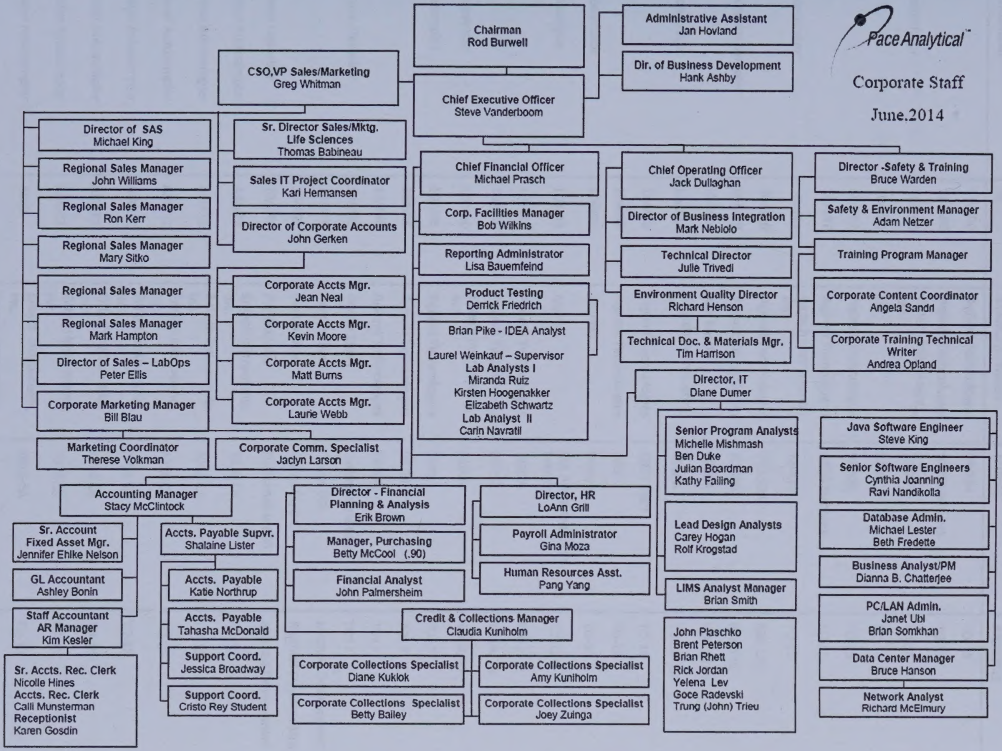
**Safety Officer
****Safety Committee Member*
(T) Temporary Employee

Virginia and Duluth, Minnesota Laboratories

ATTCHMENT IID- CORPORATE ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)


Pace Analytical
Corporate Staff
June.2014
Chairman
Rod Burwell
Administrative Assistant
Jan Hovland
Dir. of Business Development
Hank Ashby
Chief Executive Officer
Steve Vanderboom
CSO,VP Sales/Marketing
Greg Whitman
Director of SAS
Michael King
Regional Sales Manager
John Williams
Regional Sales Manager
Ron Kerr
Regional Sales Manager
Mary Sitko
Regional Sales Manager
Regional Sales Manager
Mark Hampton
Director of Sales – LabOps
Peter Ellis
Corporate Marketing Manager
Bill Blau
Marketing Coordinator
Therese Volkman
Corporate Comm. Specialist
Jaclyn Larson
Sr. Director Sales/Mktg. Life Sciences
Thomas Babineau
Sales IT Project Coordinator
Kari Hermansen
Director of Corporate Accounts
John Gerken
Corporate Accts Mgr.
Jean Neal
Corporate Accts Mgr.
Kevin Moore
Corporate Accts Mgr.
Matt Burns
Corporate Accts Mgr.
Laurie Webb
Chief Financial Officer
Michael Prasch
Corp. Facilities Manager
Bob Wilkins
Reporting Administrator
Lisa Bauemfeind
Product Testing
Derrick Friedrich
Brian Pike - IDEA Analyst
Laurel Weinkauf – Supervisor
Lab Analysts I
Miranda Ruiz
Kirsten Hoogenakker
Elizabeth Schwartz
Lab Analyst II
Carin Navratil
Chief Operating Officer
Jack Dullaghan
Director of Business Integration
Mark Nebiolo
Technical Director
Julie Trivedi
Environment Quality Director
Richard Henson
Technical Doc. & Materials Mgr.
Tim Harrison
Director -Safety & Training
Bruce Warden
Safety & Environment Manager
Adam Netzer
Training Program Manager
Corporate Content Coordinator
Angela Sandri
Corporate Training Technical Writer
Andrea Opland
Director, IT
Diane Dumer
Senior Program Analysts
Michelle Mishmash
Ben Duke
Julian Boardman
Kathy Failing
Lead Design Analysts
Carey Hogan
Rolf Krogstad
LIMS Analyst Manager
Brian Smith
John Plaschko
Brent Peterson
Brian Rhett
Rick Jordan
Yelena Lev
Goce Radevski
Trung (John) Trieu
Java Software Engineer
Steve King
Senior Software Engineers
Cynthia Joanning
Ravi Nandikolla
Database Admin.
Michael Lester
Beth Fredette
Business Analyst/PM
Dianna B. Chatterjee
PC/LAN Admin.
Janet Ubl
Brian Somkhan
Data Center Manager
Bruce Hanson
Network Analyst
Richard McElmury
Accounting Manager
Stacy McClintock
Sr. Account Fixed Asset Mgr.
Jennifer Ehlke Nelson
GL Accountant
Ashley Bonin
Staff Accountant AR Manager
Kim Kesler
Sr. Accts. Rec. Clerk
Nicolle Hines
Accts. Rec. Clerk
Calli Munsterman
Receptionist
Karen Gosdin
Accts. Payable Supvr.
Shalaine Lister
Accts. Payable
Katie Northrup
Accts. Payable
Tahasha McDonald
Support Coord.
Jessica Broadway
Support Coord.
Cristo Rey Student
Director - Financial Planning & Analysis
Erik Brown
Manager, Purchasing
Betty McCool (.90)
Financial Analyst
John Palmersheim
Director, HR
LoAnn Grill
Payroll Administrator
Gina Moza
Human Resources Asst.
Pang Yang
Credit & Collections Manager
Claudia Kuniholm
Corporate Collections Specialist
Diane Kukiok
Corporate Collections Specialist
Amy Kuniholm
Corporate Collections Specialist
Betty Bailey
Corporate Collections Specialist
Joey Zuinga

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

DEPT	INSTRUMENT	ID	MANUFACTURER	MODEL	ANALYSIS
Air	GC	10AIR0	Agilent Technologies	6890N	TO-15
Air	MS	10AIR0	Agilent Technologies	5973 Network	TO-15
Air	Concentrator	10AIR0	Entech Instruments, Inc.	7100A	TO-15
Air	GC	10AIR5	HP	5890	3C
Air	GC	10AIR7	Agilent Technologies	6890N	TO-15
Air	MS	10AIR7	Agilent Technologies	5973 Network	TO-15
Air	Concentrator	10AIR7	Entech Instruments, Inc.	7100A	TO-15
Air	GC	10AIR9	Agilent Technologies	G1530A	RSK 175
Air	Headspace Sampler	10AIR9	Agilent Technologies	G1888	RSK 175
Air	GC	10AIRA	ALS Ready	6890A	TO3 BTEX
Air	Concentrator	10AIRA	Entech Instruments, Inc.	7100A	TO3 BTEX
Air	MS	10AIRB	Agilent Technologies	5973 inert	TO-15
Air	GC	10AIRB	Agilent Technologies	6890	TO-15
Air	Concentrator	10AIRB	Markes	Unity2	TO-15
Air	Autosampler	10AIRB	Markes	CIA Advantage/CIA Satellite	TO-15
Air	GC	10AIRD	Agilent Technologies	7890A	TO14/15
Air	MS	10AIRD	Agilent Technologies	5975C	TO14/15
Air	Concentrator	10AIRD	Entech Instruments, Inc.	7100A	TO14/15
Air	Autosampler	10AIRE	Agilent Technologies	7693	TO17
Air	MS	10AIRE	Agilent Technologies	5975C	TO17
Air	GC	10AIRE	Agilent Technologies	7890A	TO17
Air	Thermal Desorber	10AIRE	Perkin Elmer	Turbomatrix 650	TO17
Air	GC	10AIRF	Perkin Elmer	Clarus 680	Method Development
Air	MS	10AIRF	Perkin Elmer	Clarus SQ 8 C	Method Development
Air	Thermal Desorber	10AIRF	PerkinElmer	Turbomatrix 650	Method Development
Air	Canister Autosampler	AIR7T1	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIR7T2	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIRBT1	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIRBT2	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIR0T1	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIR0T3	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIRD	Entech Instruments, Inc.	7016 CA	TO-15
Air	Canister Autosampler	AIRD	Entech Instruments, Inc.	7016 CA	TO-15
Air	Can Cleaning Rack	Rack 1	Pace	na	

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Air	Can Cleaning Rack	Rack 2	Pace	na	
Air	Can Cleaning Rack	Rack 3	Pace	na	
Air	Oven	10AIR10	Despatch	LDB Series	General-Air
Air	Pirani and Diaphragm Gauge	10AIR12	Vacuum Research Corp	902034	
Air	Pirani and Diaphragm Gauge	10AIR13	Vacuum Research Corp	902034	
Air	Pirani and Diaphragm Gauge	10AIR20	Vacuum Research Corp	902034	
Air	Pirani and Diaphragm Gauge	10AIR11	Vacuum Research Corp	902034	
HRMS	GCMS	10MSHR09	Agilent	6890N	1613/8290/Mthd 23,29/TO9/DW
HRMS	GCMS	10MSHR09	Waters/Micromass	Autospec Premier	1613/8290/Mthd 23,29/PCB
HRMS	GCMS	10MSHR06	Agilent	6890A	1613/8290/Mthd 23,29/1614
HRMS	GCMS	10MSHR06	Waters/Micromass	Autospec Ultima	1613/8290/Mthd 23,29
HRMS	GCMS	10MSHR10	Thermo Scientific	Trace GC Ultra	1613 DW
HRMS	GCMS	10MSHR10	Thermo Scientific	Trace GC Ultra	1613 DW
HRMS	GCMS	10MSHR10	Thermo Scientific	DFS High Resolution Magnetic Sector MS	1613 DW
HRMS	GCMS	10MSHR11	Thermo Scientific	Trace GC Ultra	1613 DW
HRMS	GCMS	10MSHR11	Thermo Scientific	Trace GC Ultra	1613 DW
HRMS	GCMS	10MSHR11	Thermo Scientific	DFS High Resolution Magnetic Sector MS	1613 DW
HRMS	GCMS	10MSHR05	Agilent	6890A	1613/8290/Mthd 23,29/DW/PCB
HRMS	GCMS	10MSHR05	Waters/Micromass	Autospec Ultima	1613/8290/Mthd 23,29
Dioxin DW	balance	10BAL1	Denver Inst	MXX-5001	1613
Dioxin Prep	balance	10BAL2	A&D	EK4100i	8290, 1613, 1668, 1614
Dioxin Prep	Micro 100 Turbidimeter	10HR14	Scientific Inc.	Micro 100 Turbidimeter	Turbidity
Dioxin Prep	Microwave	10HR13	CEM	MarsXpress	8290/1613 Solid & wipes, 1668A short list & 209 solids
Dioxin Prep	N-EVAP	N-EVAP 1	Organomation	112	General - HRMS prep
Dioxin Prep	N-EVAP	N-EVAP 2	Organomation	112	General - HRMS prep
Dioxin Prep	N-EVAP	N-EVAP 3	Organomation	112	General - HRMS prep
Dioxin Prep	Accelerated Solvent Extractor	10HR12	ACE	200	General - HRMS prep
Dioxin Prep	N-EVAP	DW1	Organomation	8125	General - HRMS prep
Dioxin Prep	N-EVAP	DW2	Organomation	8125	General - HRMS prep
Dioxin Prep	N-EVAP	N-EVAP 4	Organomation	8125	General - HRMS prep
Dioxin Prep	N-EVAP	N-EVAP 5	Organomation	8125	General - HRMS prep
Dioxin Prep	N-EVAP	N-EVAP 6	Organomation	8125	General - HRMS prep
Dioxin Prep	Oven	DP4	Lindberg Blue	GO1340A-1	General - HRMS prep
Metals	ICPMS	10ICM3	Thermo Scientific	Xseries 2	Metals

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Metals	ICPMS	10ICM4	Thermo Scientific	XII	Metals
Metals	ICPMS	10ICM5	Thermo Scientific	XII	Metals
Metals	ICPMS	10ICM8	Aglient 7700	G3281A	6020, 200.8
Metals	ICPMS	10ICM9	Aglient 7700	G3281A	
Metals	ICP	10ICP2	Perkin Elmer Instruments	Optima 4300 DV	Metals
Metals	ICP	10ICP3	Perkin Elmer Instruments	Optima 4300 DV	Metals
Metals	Mercury Analyzer	10HG3	Cetac Quick Trace	M-7500	Mercury
Metals	Mercury Autosampler	10HG3	ASX-520	MAS Ver w/Diluter	Mercury
Metals	Mercury Analyzer	10HG4	Cetac	M7600	Mercury
Metals	Heat Plate	10MET25	Cole Parmer	HS19 C-P	
Metals	Hot Block	10MET02	Environmental Express	SC154	6010/Mercury/6020/200.8/method 29
Metals	Hot Block	10MET03	Environmental Express	na	6010/Mercury/6020/200.8/method 29
Metals	Hot Block	10MET04	Environmental Express	na	6010/Mercury/6020/200.8/method 29
Metals	Hot Block	10MET05	Thomas Cain Inc.	Deena 60	Metals Prep
Metals	Hot Block	10MET08	Environmental Express	NA	Metals Prep
Metals	Hot Block	10MET09	Environmental Express	NA	Metals Prep
Metals	Hot Block	10MET10	Environmental Express	NA	Metals Prep
Metals	Hot Block	10MET22	Environmental Express	SC154	
Metals	Hot Block	10MET23	Environmental Express	SC154	6010, 6020, 200.7 and 200.8
Metals	Hot Block	10MET26	Environmental Express	SC154	
Metals	Tumbler	10MET06	Associated Design & Mfg. Co.	3740-24BRE	TCLP Prep
Metals	Tumbler	10MET20	Environmental Express	na	Metals Prep
Metals	balance	10BALD	Mettler	PM600	various soil methods
Metals	balance	10BAL4	A&D	EK-610i	6010, 200.7, 200.8, 6020, 7470, 7471, 245.1
Metals	balance	10WETD	Mettler-Toledo	PB602-5	6010, 200.7, 200.8, 6020
Metals	balance	10BAL3	Sartorius	BP 110 S	equipment calibrations
Metals	balance	10BAL5	A&D	FX1200i	1311, 1312
O-Prep	UltraSonicator	10OP17	Branson	8510	General - Oprep
O-Prep	Sonicator	10OP01	Misonix	XL 2020	3550
O-Prep	Sonicator	10OP02	Misonix	XL 2015	3550
O-Prep	Sonicator	10OP03	Misonix	Sonicator 3000	3550
O-Prep	Sonicator	10OP04	Misonix	Sonicator 3000	3550
O-Prep	Soxtherm	10OP06	Gerhardt	na	8082
O-Prep	Soxtherm	10OP07	Gerhardt	na	8082

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

O-Prep	Soxtherm	10OP08	Gerhardt	na	8082
O-Prep	Soxtherm	10OP09	Gerhardt	na	8082
O-Prep	N-EVAP	10OP10	Organomation	112	General - Oprep
O-Prep	N-EVAP	10OP11	Organomation	112	General - Oprep
O-Prep	Centrifuge	10OP13	IEC	Centra GP8	General - Oprep
O-Prep	Centrifuge	10OP14	Damon/IEC Division	na	General - Oprep
O-Prep	Centrifuge	10OP15	International Clinical Centrifuge	CL28899M	General - Oprep
O-Prep	balance	10BAL6	A&D	EK-410i	soil prep: AK, 8270, PAH, DRO, 625, 8015, 8081
O-Prep	balance	10BAL7	Denver Inst	MXX-612	soil prep: AK, 8270, PAH, DRO, 625, 8015, 8081
SVOA	GC System	10MSSA	Agilent	7890A	SIM
SVOA	Autosampler Tower	10MSSA	Agilent/HP	7693 Series	SIM
SVOA	Autosampler Tray	10MSSA	Agilent/HP	7693 Series	SIM
SVOA	MS Detector	10MSSA	Agilent/HP	5975C	SIM
SVOA	Peltier Cooling System	10MSSA	Gersel	CIS 4	SIM
SVOA	AutoSampler Tower	10MSSB	Agilent	7863B	SIM, TO13, High Volume Injection
SVOA	GC/Oven	10MSSB	Agilent	7890	SIM, TO13, High Volume Injection
SVOA	MS Detector	10MSSB	Agilent	5975C	SIM, TO13, High Volume Injection
SVOA	AutoSampler Tray	10MSSB	Agilent	7683	SIM, TO13, High Volume Injection
SVOA	Peltier Cooling System	10MSSB	Gersel	CIS 4	SIM, TO13, High Volume Injection
SVOA	GC	10MSSD	Agilent	6890N	8270, PCP SIM
SVOA	MS	10MSSD	Agilent	5975	8270, PCP SIM
SVOA	Autosampler	10MSSD	Agilent	G2614 A	8270, PCP SIM
SVOA	Tower 7683B	10MSSD	Agilent	62915A	8270, PCP SIM
SVOA	MS	10MSS3	HP	5973	CPAH, PCP
SVOA	GC	10MSS3	HP	6890	CPAH, PCP
SVOA	Autosampler Tray	10MSS3	Agilent/HP	7683	CPAH, PCP
SVOA	Injector Tower	10MSS3	Agilent/HP	7683	CPAH, PCP
SVOA	Autosampler Tray	10MSS3	Agilent/HP	7683	CPAH, PCP
SVOA	GC	10MSS6	Agilent	6890N	SIM, PCP
SVOA	Autosampler Tower	10MSS6	Agilent/HP	7683	SIM, PCP
SVOA	MS	10MSS6	Agilent/HP	5973N	SIM, PCP
SVOA	Autosampler Tray	10MSS6	Agilent/HP	7683	SIM, PCP
SVOA	GC	10MSS7	Agilent	6890N	8280
SVOA	Tower 7683	10MSS7	Agilent	62613A	8280
SVOA	Turret 7683	10MSS7	Hewlet Packard	62614A	8280

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

SVOA	Mass Spec 5973	10MSS7	Agilent	62579A	8280
SVOA	AutoSampler Tower	10MSS8	Agilent/HP	7683	Sulfolane, 8270, 625
SVOA	GC/Oven	10MSS8	Agilent	6890 N	Sulfolane, 8270, 625
SVOA	MS Detector	10MSS8	Agilent	5973 N	Sulfolane, 8270, 625
SVOA	AutoSampler Tray	10MSS8	Agilent/HP	7683	Sulfolane, 8270, 625
SVOA	GC/Oven	10MSS9	Agilent	6890 A	8270, 625
SVOA	AutoSampler Tower	10MSS9	Agilent	18593B	8270, 625
SVOA	MS Detector	10MSS9	Agilent	5973 N	8270, 625
SVOA	AutoSampler Tray	10MSS9	Agilent	18596C	8270, 625
SVOA	Dual Microcell ECD	10GCSA	Agilent	6890N	8081
SVOA	Autosampler	10GCSA	Agilent	G2614 A	8081
SVOA	Tower	10GCSB	Agilent	64513A	8081
SVOA	Tray	10GCSB	Agilent	64514A	8081
SVOA	GCECD	10GCSB	Agilent	7890A	8081
SVOA	GC Oven	10GCS4	HP	5890	WIDRO
SVOA	AutoSampler /Tower	10GCS4	HP	7673A	WIDRO
SVOA	AutoSampler Tray	10GCS4	HP	7673A	WIDRO
SVOA	GCECD	10GCS7	Agilent	6890 N	PCB
SVOA	AutoSampler Tray	10GCS7	Agilent/HP	64514A	PCB
SVOA	Tower	10GCS7	HP N279	N279	PCB
SVOA	GC Oven	10GCS8	Agilent	6890 N	8015, NwTPH, AK102, AK103
SVOA	AutoSampler	10GCS8	Agilent/HP	7683	8015, NwTPH, AK102, AK103
SVOA	Tower	10GCS8	Agilent/HP	7683	8015, NwTPH, AK102, AK103
SVOA	GC	10GCS9	Agilent	7890	DRO
SVOA	Tower	10GCS9	Agilent	64513A	DRO
SVOA	Autosampler Tray	10GCS9	Agilent	64514A	DRO
SVOA	GC Oven	10GCSC	Agilent	6890 N	8015, NwTPH, AK102, AK103, WIDRO
SVOA	AutoSampler	10GCSC	Agilent/HP	62614A	8015, NwTPH, AK102, AK103, WIDRO
SVOA	Tower	10GCSC	Agilent/HP	62614A	8015, NwTPH, AK102, AK103, WIDRO
SVOA	balance	10MPR2	Mettler	AE200	Dry Weight Analysis
VOA	AutoSampler	10MSV1	Environmental Sample Tech, Inc.	na	UST, BTEX
VOA	Concentrator	10MSV1	Tekmar	3000	UST, BTEX
VOA	GC	10MSV1	HP	6890	UST, BTEX
VOA	MS	10MSV1	HP	5973	UST, BTEX
VOA	GC	10MSV3	Agilent	6890	8260 Med. Lvl Soil
VOA	AutoSampler	10MSV3	EST Analytical	Centurion	8260 Med. Lvl Soil
VOA	Concentrator	10MSV3	Encon Evolution	na	8260 Med. Lvl Soil

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

VOA	MS	10MSV3	Agilent	5973	8260 Med. Lvl Soil
VOA	AutoSampler	10MSV5	EST Analytical	Centurion	8260/624/TCLP/UST
VOA	Concentrator	10MSV5	Encon Evolution	na	8260/624/TCLP/UST
VOA	GC	10MSV5	HP	6890	8260/624/TCLP/UST
VOA	MS	10MSV5	HP MS	5973	8260/624/TCLP/UST
VOA	AutoSampler	10MSV6	Varian Archon	na	524/8260/624
VOA	Concentrator	10MSV6	Tekmar	3000	524/8260/624
VOA	GC	10MSV6	Agilent	6890A	524/8260/624
VOA	MS	10MSV6	Agilent	5973	524/8260/624
VOA	AutoSampler	10MSV7	Environmental Sample Tech, Inc.	na	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	GC	10MSV7	Agilent Technologies	6850	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	Concentrator	10MSV7	Tekmar	3000	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	MS	10MSV7	Agilent Technologies	5975C	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	GC	10MSV8	5975C	5975C	8260/624/TCLP/UST
VOA	AutoSampler	10MSV8	EST Analytical	Centurion	8260/624/TCLP/UST
VOA	Concentrator	10MSV8	Encon Evolution	na	8260/624/TCLP/UST
VOA	MS	10MSV8	Agilent	5975C	8260/624/TCLP/UST
VOA	Concentrator	10MSV9	Tekmar	14-3100-OEL	8260 - oxygenates
VOA	GC	10MSVA	Agilent	6890	
VOA	MS	10MSVA	Agilent	5973	
VOA	autosampler/concentrator	10MSVA	Tekmar	Atomx 15-0000-100	
VOA	Concentrator	10MSVB	EST	Evolution	
VOA	GC	10MSVC	Agilent	6890N	
VOA	AutoSampler	10MSVC	O-I-Analytical Eclipse	Archon 4552	
VOA	Concentrator	10MSVC	O-I-Analytical Eclipse	4660	
VOA	AutoSampler	10GCV1	Environmental Sample Tech, Inc.	na	
VOA	Concentrator	10GCV1	Tekmar Dohrmann	3100	
VOA	AutoSampler	10GCV3	EST Analytical	Centurion	8021, WIGRO
VOA	Concentrator	10GCV3	Tekmar Dohrmann	3000	8021, WIGRO
VOA	GC	10GCV3	HP	5890 Series II	8021, WIGRO
VOA	AutoSampler	10GCV5	Environmental Sample Tech, Inc.	na	8015/NWTPH-Gx/AK101
VOA	Concentrator	10GCV5	Tekmar	3100	8015/NWTPH-Gx/AK101
VOA	GC	10GCV5	HP	G1530A	8015/NWTPH-Gx/AK101
VOA	AutoSampler	10GCV6	EST Analytical	Archon 8100	8021/8015/GRO/NwTPH
VOA	Concentrator	10GCV6	Tekmar	14-3100-EOL	8021/8015/GRO/NwTPH
VOA	GC	10GCV6	Agilent/HP	HP 6890	8021/8015/GRO/NwTPH

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

VOA	AutoSampler	10GCV7	Environmental Sample Technology	Archon	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	Concentrator	10GCV7	Tekmar 3000	14-3000-000	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	GC	10GCV7	HP	Series II 5890	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	AutoSampler	10GCV8	Environmental Sample Technology	Archon	
VOA	Concentrator	10GCV8	Tekmar	3000	
VOA	GC	10GCV8	HP	Series II 5890	
VOA	Oven	10VOA03	Thermo Scientific	NA	General - VOA
VOA	Sonicator	10VOA04	Fisher Scientific	FS220	8260/8021/8015/GRO
VOA	Concentrator	Unassigned	O I Analytical	Eclipse 4660	
VOA	Autosampler	Unassignged	Archon	5100A	
VOA	balance	10BAL9	A&D	FX-3200	
VOA	balance	10BALA	A&D	EK-300i	
VOA	balance	10BALE	Mettler	AE200	
Wet Chem	Incubator	10WET16	Fisher Scientific	Isotemp Incubator	BOD
Wet Chem	Incubator	10WET22	Fisher Scientific	307	BOD
Wet Chem	Incubator	10WET35	Fisher Scientific	307C	BOD
Wet Chem	Incubator	10WET60	Thermo Forma	3940	BOD
Wet Chem	Autotitrator	10WET6	Metrohm	888 Titrando Titrator	Alkalinity SM2320B
Wet Chem	Autosampler	10WET6	Metrohm	778 Sample Processor	Alkalinity SM2320B
Wet Chem	Diss. Oxy Meter	10WET51	YSI	5000	BOD
Wet Chem	Oven	10WET17	Precision Scientific	130 DM	General - Wet Chem
Wet Chem	Oven	10WET20	Fisher Scientific	Isotemp Oven	General - Wet Chem
Wet Chem	AutoClave	10WET29	Harvey	na	General - Wet Chem
Wet Chem	pH Meter	10WET7	Orion	na	pH
Wet Chem	pH Meter	10WET31	IQ Scientific Instruments	na	pH
Wet Chem	Thermoreactor	10WET26	Neutec Group Inc.	ECO 25	COD
Wet Chem	COD Reactor	10WET11	Bioscience, Inc.	na	COD
Wet Chem	KoneLab Discrete Analyzer	10WET3	Thermo Fisher Scientific	Konelab 20	Colormetric - Cl, HexChrom, Cyanide, ophos, NO2, phenol, SO4
Wet Chem	Conductivity meter	10WET9	Oaktom	Con 110 Series	Specific Conductivity
Wet Chem	Colony Counter	10WET30	Gallenkamp	Colony Counter	HPC
Wet Chem	Colony Counter	10WET38	Darkfield Quebec	Colony Counter	HPC
Wet Chem	Water Bath	10WET27	Fisher Scientific	Isotemp 210	General - Wet Chem
Wet Chem	Distillation Block	10WET12	Environmental Express	na	SM4500-P-E
Wet Chem	Distillation Block	10WET13	MIDI-STIL	na	SM4500-P-E

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Wet Chem	Spectrometer	10WETA	Hach	DR 2700	COD
Wet Chem	Hot Plate	10WET34	Presto	Tilt'n Drain Big Griddle	General - Wet Chem
Wet Chem	Smart Chem Discrete Analyzer	10WT36	West Co Scientific Instruments	Smart Chem 200	Colormetric - NH3, NO3, Tphos, cyanide
Wet Chem	Hot Plate	10WET40	Corning	na	General - Wet Chem
Wet Chem	Stir Plate	10WET41	Fisher Scientific	na	General - Wet Chem
Wet Chem	Stir Plate	10WET42	Barnstead/Thermolyne	S46725/Cimarec 2	General - Wet Chem
Wet Chem	Stir Plate	10WET43	Fisher Scientific	na	General - Wet Chem
Wet Chem	Vortex Mixer	10WET44	American Scientific Prod.	S8223-1	General - Wet Chem
Wet Chem	Extractor	10WET45	Horizon Technology	Spe-dex 4790	Oil & Grease
Wet Chem	Extractor	10WET46	Horizon Technology	Spe-dex 4791	Oil & Grease
Wet Chem	Extractor	10WET47	Horizon Technology	Spe-dex 4792	Oil & Grease
Wet Chem	Extractor	10WET48	Horizon Technology	Spe-dex 4793	Oil & Grease
Wet Chem	Closed Cup - Penske	10WT49	Precision Scientific	na	Flash Point
Wet Chem	pH/BOD meter	10WT54	Hach	LBOD10101	BOD
Wet Chem	pH/BOD meter	10WT53	Hach	HQ40d	BOD
Wet Chem	Hot Block	10WET55	Environmental Express	na	COD
Wet Chem	Oven	10WT56	Lindberg/Blue M	MO1450PSA-1	General - Wet Chem
Wet Chem	Oven	10WET65	Fisher Scientific	13-247-650G(6905)	General - Wet Chem
Wet Chem	pH Probe	11662571034	Hach	PHC301	pH
Wet Chem	pH Probe	121952571033	Hach	PHC301	pH
Wet Chem	pH Probe	122143032067	Hach	LBOD101	pH
Wet Chem	pH Probe	712202002	Switchcraft	PHW77-SS	pH
Wet Chem	Turbidity Meter	10WT59	Hach	2100Q	Turbidity
Wet Chem	Hand Held Brix Refractometer	10WT60	Fisher	na	
Wet Chem	Oven	10WET19	VWR Scientific	1370F	General - Wet Chem
Wet Chem	Quanti-Tray Sealer Model 2x	10WET56	Quanti-Tray	89-10894-02	SM9223B
Wet Chem	IC	10WT61	Metrohm	881 Compact IC	EPA Method 300.0
Wet Chem	Lachat	10WT62	Quick Chem	8500	SM4500Cl-E, SM4500P-E, SM3500CrB, EPA 420.4
Wet Chem	Autotitrator	10WT63	Metromn	905 USB Sample Processor	Alkalinity SM2320B
Wet Chem	Fluoride Probe	10WET64	Hanna Instruments	HI 98402	Fluoride
Wet Chem	JT Backer Speedisk Expanded Extration Station	10WET66	J.T. Baker	Speedisk Expanded Extraction Station	
Wet Chem	COD/Cyanide Block (dual reactor, two heat blocks)	10WET67	Hach	DRB 200	COD
Wet Chem	Desiccator	10WET68	Sanplatec Corp	DryKeeper	

ATTACHMENT IIIA- MINNEAPOLIS EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Wet Chem	Desiccator	10WET69	Boekel	na	
Wet Chem	Desiccator	10WET70	Boekel	na	
Wet Chem	Desiccator	10WET71	Boekel	na	
Wet Chem	Desiccator	10WET72	Boekel	na	
Wet Chem	Desiccator	10WET73	Boekel	na	
Wet Chem	Desiccator	10WET74	Boekel	na	
Wet Chem	Desiccator	10WET75	Boekel	na	
Wet Chem	Meter	10WETE	Hach	HQ440d	ph, conductivity, redox
Wet Chem	Oven	10WET77	Fisher Isotemp Oven	6905	General - Wet Chem
Wet Chem	Oven	10WET78	Fisher Isotemp Oven	6905	General - Wet Chem
Wet Chem	balance	10WETB	Sartorius	RC 210 P	9071, 1664
Wet Chem	balance	10BALF	Mettler	AJ100	various
Wet Chem	balance	10BALG	ExplorerPro	EP114C	TSS/TDS
Wet Chem	balance	10BALH	Denver Instrument	MXX-612	various
Wet Chem	balance	10BALB	Ohaus	Scout Pro (SPE 202)	9045, 9071
Wet Chem	balance	10WETC	Sartorius	AC 210 S	TSP, PM10
Wet Chem	balance	10WET4	Mettler-Toledo	AB135-S	2540
Wet Chem	balance	10BALC	Sartorius	LA3200D	humidity cell analysis

ATTACHMENT IIIB- MONTANA EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

PACE ID	INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER
2048	NIST Thermometer	Ertco	-1 to 100 C	2048
2201	NIST Thermometer	ThermoFisher	-1 to 201 C	2201
111877001	NIST Thermometer	Fisher Scientific	15-077-55; 255NK; FB50262	111855001
133	Thermometer			
1065	Thermometer			
3114	Thermometer			
3146	Thermometer			
2348	Thermometer			
5527	Thermometer			
6000	Thermometer			
6578	Thermometer			
7656	Thermometer			
22734	Thermometer			
10344	Thermometer			
Z180878	Thermometer	Extech Instruments	421502	Z180878
14211	Thermometer	Ertco	-30 - 0 °C	14211
14336	Thermometer	Ertco	-30 - 0 °C	14336
80524569	Thermometer			-
20507	Thermometer	Ertco	-30 - 0 °C	20507
1383045	IR Gun	Oakton	InfraPro	1383045
11BAL0 (24353410)	Balance	Denver	MXX-212	24353410
11BAL1 (14138)	Balance	Fisher	7227DA	14138
11MT09 (40020019)	Balance	Sartorius	LC620S	40020019
11MT07 (B027060)	Balance	Fisher	A200DS	B027060
11BAL2 (G3251202300491)	Balance	Ohaus	ARC120	G3251202300491
11BAL3 (E86392)	Balance	Mettler	AE100	E86392
1000062197	2kg Weight	Troemner	2kg	1000062197
6433380081	5mg Weight	Mettler Toledo	5mg	6433380081
01-J54434-46	Weight Set	Denver Instrument	10 gram	01-J54434-46
01-J54881-26	Weight Set	Denver Instrument	50 gram	01-J54881-26
01-J54942-47 and 01-J54223-43	Weight Set	Denver Instrument	1g & 5g	01-J54942-47 and 01-J54223-43
01-J55139-14	Weight Set	Denver Instrument	100 gram	01-J55139-14
18156	Weight Set	Christian Becker		
99-J51026-14	Weight Set	Denver Instrument	500 gram	99-J51026-14
7628	Weight Set	Troemner	50g,2-20g, 10g, 5g, 2-2g	7628
40111	Weight Set	Troemner	100g, 50g, 2-20g, 10g, 5g, 2-2g, 1g, 100mg, .01mg	40111
99-10964	Weight Set	Denver Instrument	50g, 30g, 20g, 10g, 5g, 3g, 2g, 1g	99-10964
1000016506	0.01 g Weight	Troemner	0.01g	1000016506
11MT03	SVOA GC	Hewlett-Packard	5890A	3235A46830
11MT03	Autosampler	Hewlett-Packard	7673	3120A27948

ATTACHMENT IIIB- MONTANA EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

11MT03	Autosampler	Hewlett-Packard	7673	3048A24383
11MT04	Autosampler	Hewlett-Packard	7673	3225A31213
11MT04	Autosampler	Hewlett-Packard	7673	3120A28856
11MT04	SVOA GC	Hewlett-Packard	5890	275A16778
11MT05	IC Autosampler	Dionex	AS40-1	7101378
11MT05	Ion Chromatograph	Dionex	ICS1000	05120175
11MT06	Autoanalyzer Autosampler	Astoria Pacific	311	311162
11MT06	Autoanalyzer Detector	Astoria Pacific	305A	305352
11MT06	Autoanalyzer Heater Unit	Astoria Pacific	303A	303437
11MT06	Autoanalyzer Photometer	Astoria Pacific	350	350376
11MT06	Autoanalyzer Power Supply	Astoria Pacific	304A	304224
11MT06	Autosampler power supply	Perstorp	509	5766
11MT06	Autosampler pump	Perstorp	502	818?5??-212
11MT08	Spectrophotometer	Spectronic	Aquamate	104218
11MT10	Oven	Fisher	Isotemp 255D	1451
11MT11	Oven	Fisher	Isotemp 630F	20900168
11MT12	Muffle Furnace	Sybron	Thermolyne	32400731
11MT13	Concentrator	Zymark	TurboVap II	TB9814N8062
11MT14	Concentrator	Zymark	TurboVap II	4082
11MT15	Furnace	Sybron Thermolyne	1300	0479 16654
11MT16	N-Evap	Organomation	112	11771
11MT17	Waterbath	Northwest Fixtures	I5505	246T
11MT18	pH meter	Fisher	AR50	81207936
11MT19	Sonicator	Fisher	FS60	RUA080390744
11MT20	Centrifuge	Fisher	Centific	406N0169
11MT22	Furnace	Leco	S-144DR	3167
11MT23	Turbidimeter	HF Scientific	Micro 1000	610064
11MT24	Sonicator	Heat Systems	Sonicator XL	Can't read
11MT25	Sonicator	Branson	Sonfier 450	B1090019
11MT28	Microscope*	Olympus	BH-2	217295
11MT29	Microscope*	Olympus	BH-2	230579
11MT30	Stereoscope	Fisher	8711	
11MT31	Steroscope	Olympus	G10X	340704
11MT32	Microscope*	Olympus	BH-2	242833
11MT33	Concentrator	Tekmar/Dohrmann	Tekmar 3000 Purge and Trap concentrator	96312005
11MT33	VOA GC	Aglient	6890	US00009537
11MT33	Autosampler	EST	Centurion	CENT-W-417042312
11MT34	Block Digestor	Lachat	BD-46	1800-733
11MT35	Oven	Precison	NA	603041552
11MT38	AutoSampler	O-I-Analytical	4552	
11MT38	Concentrator	Tekmar Dohrmann	3100	99274012
11MT38	GC System	Agilent	6890	US00032765
11MT38	MS Detector	Agilent	5973	US94240027
11MT39	Thermoreacter	VELP Scientifica	F101A0125	197853
11MT40	pH meter	Accumet	AR50	81207936

ATTACHMENT IIIB- MONTANA EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

11MT41	Oven	Fisher	Isotemp 630F	
11MT42	Oven	Precision Scientific	Thelco 130 DM	9212-016
11MT43	GC System	Agilent	6890	US00021845
11MT43	Concentrator	EST	Evolution	EV431073112
11MT43	AutoSampler	EST	Centurion	CENT-W-416041012
11MT44	Flow Analyzer	Lachat	8500	120400001407
11MT47	Sieve Shaker	Gilson	SS-15	6290
11MT48	Sieve Shaker	W.S. Tyler	RX_29	10-2394
11MT49	Sieve Shaker	Gilson	SS-15	6289
11MT50	Sieve Shaker	Gilson	SS-84	1587
11MT51	Concentrator	Zymark	Turbo Vap II	4254
11MT52	GC System	HP	5890 series 2	336A53379
11MT52	Autoinjectors (2)	HP	7673	3120A27091 & 3249A33250
11MT53	Concentrator	Zymark	TurboVap II	TV1012N15747
11MT54	Ion Chromatograph	Dionex	LC20	10748
11MT54	IC Conductivity Detector	Dionex	CD25	04040488
11MT54	IC Isocratic pump	Dionex	IP25	04030145
11MT55	Custom Shaker	Custom	NA	NA
11MT56	Oven	Fisher516G		801N0068
11MT57	Autoclave	ThermoFisher	ST75925	1277081210300
11MT58	Metals Block Digester	Environmental Express	Hot Block	S388CEC2479
11MT59	UV VIS Spectophotometer	Varian	Cary50BIO	EL98033269
11MT60	ICP	ThermoFisher	ICAP6500 Duo	20071505
11MT60	Autosampler	CETAC	ASX-520	71011378
11MT60	Chiller	ThermoFisher	ThermoFlex900	51520175
11MT61	Centrifuge	Damon	IEC HN-S	34721368
11MT62	Block Digestor	Lachat	BD-46	1800-296
11MT64	Handheld pH	Thermo Scientific	Star A121	H00013
11MT65	Spectrophotometer	Thermo Scientific	Evolution 201	5A4S008017
FSA4	Autopipette	Hamilton	1000 uL Adj. Vol.	078490
FSA5	Autopipette	Hamilton	999 uL Adj. Vol.	078778
FSA6	Autopipette	Hamilton	300 uL Adj. Vol.	078528
IN-1103 - WC4	Autopipette	Oxford	1000-5000uL	E02008781
IN-1104 - IC2	Autopipette	Eppendorf	500-2000uL	4609456
IN-1106 - IC3	Autopipette	Gilson	50-2000uL	Z54657M
WC2	Autopipette	Eppendorf	0.1-1mL	4035876
WC3	Autopipette	Eppendorf	0.1-1mL	4038286
WC6	Autopipette	Eppendorf	20-200uL	4078539
WC7	Autopipette	Finnpipette	1-10mL	GJ45632
WC5	Autopipette	Hamilton	1-101-10mL	33269
MET1	Autopipette	Hamilton	.05-.3mL	80395
MET2	Autopipette	Hamilton	0.1-1mL	80953
IC4	Autopipette	Hamilton	0.1-1mL	81405
IC5	Autopipette	Finnpipette	0.5-5mL	KH11148
N/A	Pulverizer	Retsch	RS100	

ATTACHMENT IIIB- MONTANA EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

N/A	Vacuum Pump	Edwards	E2M2	41032
N/A	Vacuum Pump	Dayton	SA55NXGTB-4142	E22922
DocuTemp	Automated Temperature Monitoring System	DocuTemp	2.0.365	

*All microscopes cleaned 10-25-10

ATTACHMENT IIIC- VIRGINIA EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

DESCRIPTION	MANUFACTURER	MODEL #/SN#
CVAA Mercury Analyzer	Cetac	M-6100/060402 QT6
Autosampler	Cetac	ASX-400/070401 ASX-4
Hardware	Venture Systemax	SYX PHM800PRO/106381144
Software	Cetac	Quicktrace Hg Analyzer System Version 1.2.1
Graphite Furnace AA	Perkin Elmer	A/S 800/8444
Autosampler	Perkin Elmer	ASX 520 / 090511A520-06
FIAS 400 Hydride Chemifold	Perkin Elmer	400511051103
Hardware	Dell	Optiplex GX1/06UQ4
Software	Perkin Elmer	AA Winlab Instrument Control Software Ver3.9
ICP Atomic Emission Spectrometer	Perkin Elmer	Optima 3000XL/069N4081202
Autosampler	Cetac	ASX-520/090511A520-new in 2006
Hardware	Compudyne	X86 Model 7/4747
Software	Perkin Elmer	Winlab 32 ICP Optical Emission Software Ver2.2
ICPMS Atomic Emission Spectrometer	Perkin Elmer	ELAN 9000 / AJ11920712
Autosampler/Pump	Perkin Elmer	S10/102S8010517
Recirculator	Polyscience	NA
Software	Perkin Elmer	Version 3.4
Hardware	Dell XP	X12-51522
Lachat	Zellweger Analytics	Lachat Quikchem FIA+ 8000 Series/A83000-1480
Lachat Reagent Pump	Zellweger Analytics	RP-150 Series/A82000-1527 replacement 2005
Autosampler	Cetac	ASX-500 Model No 510/109932ASX
Autodilutor	Zellweger Analytics	8000 Series/A81010-277 Out of service ~2002
Micro Distillation Equipment (Ammonia)	Lachat MicroDist 5/09	081200001033
Block Digester	Lachat	BD-46/1800-408
Hardware	Midwest Comp Depot	3035
Software	Omnion	FIA Data System
Ion Chromatograph 12WTA2	Metrohm	861 Advanced Compact IC/48614011
Regenerant Dispenser	Metrohm	None
Autosampler	Metrohm	Model 838 Advanced Sample Processor
Hardware	Dell	SN#CBDUC284-70821-553-OGIP
Software	Metrohm	IC Net 2.3
Ion Chromatograph 12WTA7	Metrohm	Model 881 Advanced Compact IC 1881000122119
Regenerant Dispenser	Metrohm	800 Dosino
Autosampler	Metrohm	Model 858 Advanced Sample Processor
Hardware	Dell	Optiplex 790
Software	Metrohm	IC Net 2.3
BOD Warmer #1	Thermo Precision	60541072
BOD Incubator #1	VWR	Model 2020/09065105
BOD Incubator #2	VWR	Model 2020/0902090

ATTACHMENT IIIC- VIRGINIA EQUIPMENT LIST CONTINUED
(CURRENT AS OF ISSUE DATE)

BOD Incubator #3	VWR	Model 2020/2107705
BOD Reader	Thermo Electron Corp	BOD Auto EZ BOD Reader 10060020/A0074
BOD Hardware	Hewlett Packard/Compaq	24A41601N8
BOD Software	Thermosystems	BOD Auto EZ 2001
TOC 12WTA3	OI Analyzer	SN H129732449E
TOC	OI Autosampler	SN E129788451
TOC	OI Solids Analyzer	SN A129733824
Autosampling Module	OI Corporation	No Model/621290637-92120
IR Detector	OI Corporation	No Model/2A0002T
Hardware	HP	Compaq
Software	OI Corporation	V1.4.2
TOC 12WTA8	OI Analyzer	SN P407730312P
Autosampling Module	OI Corporation	Model 1088 AS
IR Detector	OI Corporation	Model 1030
Hardware	Lenovo	Thinkcentre
Software	OI Corporation	1.4.2
Drying Oven 1996	Blue M	OV-18C
Furnace 2005	Barnstead/Thermolyne	62700/BT010507A
Solids Balance	ADA	71/L/AE04260556
Hardware 2004	ABS	52X MTRP/10085322
Software 2004	EZ Solids	EZ_Solids Program June 23, 2004
Expandable Ion Analyzer	Orion	940/6673
Autosampler	Orion	AS 3000/B0019
Bacteria Incubator	Shel Lab / New 3/07	1545/11052906
Coliform Incubator Bath	ThermoFisher/New 4/07	253/SN202682-185
Microscope 10X/30X	National Optical/New 2/07	446TBL-10
Bacteria Incubator	Shel Lab 1996 (Sterility chk)	1520
Quanti Tray Sealer	IDEXX	89-10894-02 4788
Oven 2005	VWR	1330GM/05039804
Oven	TEMPCON	P10734
Water Bath	Fisher Scientific	FS140/FS010507
Metals Digestion Blocks (HB1; HB2)	CPI	05-C0530/000424 1005-CPI ModBlock Inst
Balance (Metals) 12BAL3	AND	GF 1200 / 10318953
Balance	Sartorius	LA 3200D / 13407528
Balance	Sartorius	Genius / 13003773
Stir Plate	Thermoline Type 7200	903971255007
Refrigerator 2R (Metals)	Sanyo	SR-362OK/051105496-new 6/30/06
Refrigerator #3	True Mfg Co.	T-49/1-2953805
Refrigerator #5	True Mfg Co.	T-49/1-3060851
Refrigerator #8	True Mfg Co	T-35/I-3016399
Refrigerator #10	Gibson	NTS Fridge #10 at 526 NTS
Refrigerator #12	Beverage-Air	9029136/KR481AS
Refrigerator #13	US Cooler Walk-in	29716
Mixer	Thermolyne	M37615/376950140798
Stir/Hotplate	VWR	12365-392 / 050914023

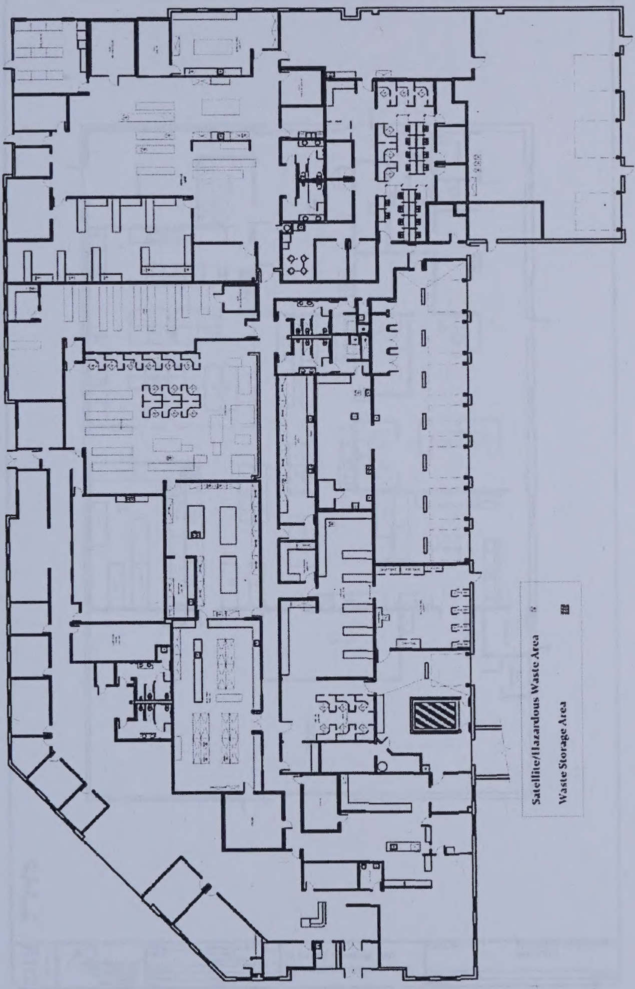
ATTACHMENT IIIC- VIRGINIA EQUIPMENT LIST CONTINUED (CURRENT AS OF ISSUE DATE)

COD Reactor-Hot block	HACH	45600-00/920600007477
COD Reactor- Hot block	HACH	16500-10/5944
Dessicator	Labconco	55300/171400
Dessicator	Labconco	55300/232878
Mixer	Fisher Scientific	Model 15/103
Rotator	Lab-Line	Model 1345/1002-1791
Balance Extraction/Solids	Acculab	VI 600/027UC1079
Autoclave	Tuttnauer/Brinkmann	3545EP
pH Meter	Orion	550A / 016948
Turbidimeter 12WET4	HF Scientific	39957 / 10621
Dissolved Oxygen Meter	YSI	5100
BOD Software	YSI	5120 BODANALYST
Spectrophotometer	HACH	DR 5000
Water Purification System, DI	Barnstead	E-Pure
Water Purification System, RO pure LP Low pressure RO System	Barnstead Thermolyne	Model D2622 SN 496000209600 Cartridge Changes noted in log book
Resistivity Meter for RO system	Sybron Barnstead	Model 02770 Resistivity Log Sheet is posted by system

ATTACHMENT IIID- DULUTH EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

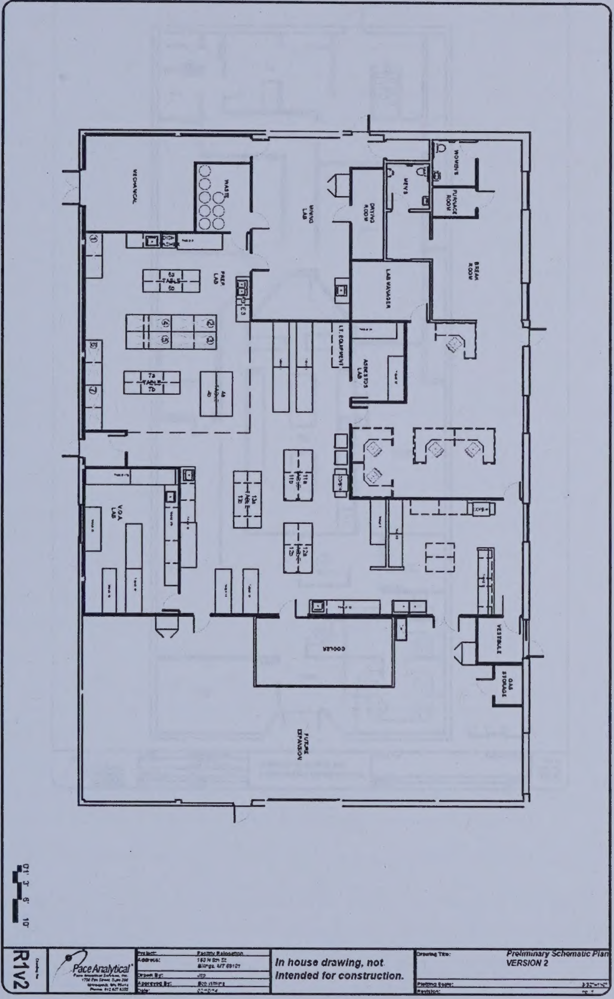
DESCRIPTION	MANUFACTURER	MODEL #/SN#
Water Purification System	Barnstead D4641	1090090938202
Refrigerator D-1	Admiral	LTS2112ARW
Refrigerator D-2	Estate Whirlpool	TT18AK
Mercury Analyzer CVAFS	Brooks Rand Model III	11026201
Autosampler	Brooks Rand PS	4936A14632
Total Hg Purge and Trap	Brooks Rand Merx	11078001
Hg Speciation Purge and Trap	Brooks Rand Merx	41107301
Hardware	XPRO Systems	
Software	Mercury Guru	4.1
Balance	Sartorius ME14145	13003775
Hood DB-1	Esco	04ESC
Hood DB-2	Esco	04ESC
Hood 3 DE-1 Perchloric Acid Hood	Labconco	
Bacteria Incubator	Thermco Precision	605031678

ATTACHMENT IVA- MINNEAPOLIS LABORATORY FLOOR PLAN (CURRENT AS OF ISSUE DATE)



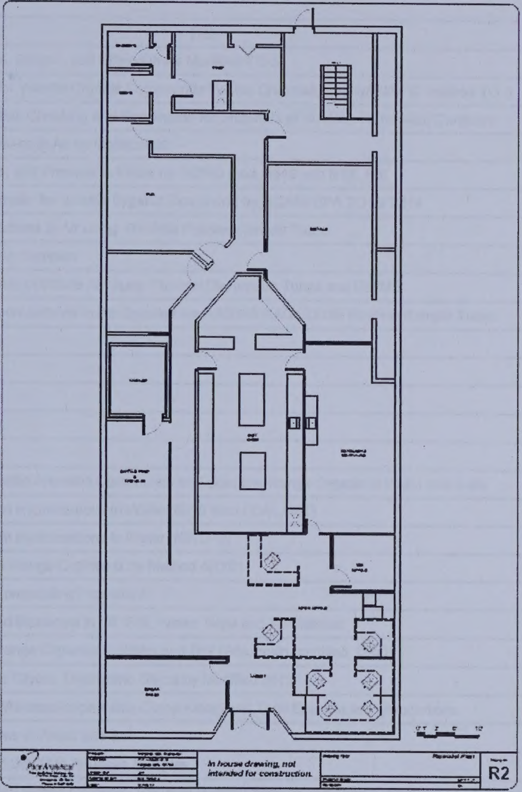
Satellite/Hazardous Waste Area
Waste Storage Area

ATTACHMENT IVB- MONTANA LABORATORY FLOOR PLAN (CURRENT AS OF ISSUE DATE)



MECHANICAL
WASTE
PREP LAB
DRYING ROOM
MEN'S
WOMEN'S
FURNACE ROOM
BREAK ROOM
LAB MANAGER
LT. EQUIPMENT
ASBESTOS LAB
VOA LAB
COOLER
VESTIBULE
GAS STORAGE
FUTURE EXPANSION
0' 3' 6' 10'
R1v2
Pace Analytical®
In house drawing, not intended for construction.
Drawing Title:
Preliminary Schematic Plan VERSION 2

ATTACHMENT IVC- VIRGINIA LABORATORY FLOOR PLANS (CURRENT AS OF ISSUE DATE)



In house drawing, not intended for construction.
R2

ATTACHMENT VA- MINNEAPOLIS SOP LIST (CURRENT AS OF ISSUE DATE)

Title	SOP Number
Determination of Methane, Ethane, and Ethene in Air Modified TO-3	S-MN-A-002
Analysis of Air Samples for Volatile Organic Compounds by Gas Chromatography/PID-FID method TO-3	S-MN-A-003
Cleaning, Certification, Leak Checking and Preparation for Shipment of SUMMA Passivated Canisters	S-MN-A-004
Determination of Fixed Gases in Air by Modified 3C	S-MN-A-005
Methane, Ethane, Ethene, and Propane in Water by GCFID mod. 3810 and RSK 175	S-MN-A-007
Analysis of Whole Air Sample for Volatile Organic Compound by GC/MS EPA TO15/TO14	S-MN-A-013
Determination of Hydrocarbons in Air using Radiello Passive Sample Tubes	S-MN-A-017
Analysis of TO17 Active Air Samples	S-MN-A-018
Analysis of BTEX and PAHs in Whole Air Using Thermal Desorption Tubes and GC/MS	S-MN-A-019
The Determination OF Hydrocarbons in Air Samples via RAD145 RADIELLO® Passive Sample Tubes	S-MN-A-020
Sample Management	S-MN-C-001
Bottle Preparatation	S-MN-C-003
Subcontracting Samples	S-MN-C-004
Internal Chain of Custody	S-MN-C-005
Percent Solids (Moisture)	S-MN-I-367
The Determination of Specific Aromatic Compounds and Gasoline Range Organic in Water and Soils	S-MN-O-427
Purgeable Total Petroleum Hydrocarbons in Water (8015 Mod / CA LUFT)	S-MN-O-525
Purgeable Total Petroleum Hydrocarbons in Water (NWTPH)	S-MN-O-555
Determination of Gasoline Range Organices by Method AK101	S-MN-O-556
Volatiles Water Sample Compositing Procedure	S-MN-O-541
Analysis of Polychlorinated Biphenyls in Oil, Soil, Water, Wipe and Air Matrixes	S-MN-O-432
Determination of Diesel Range Organics in Water and Soil (Wisconsin modified DRO)	S-MN-O-466
Ethylene glycol, Propylene Glycol, Triethylene Glycol by Modified 8015	S-MN-O-533
Saturated Hydrocarbons (Alkanes/Isoprenoids Compounds) and Total Extractable Hydrocarbons	S-MN-O-567
Determination of Pesticides in Water and Soil	S-MN-O-574
Determination of EDB and DBCP in Aqueous Samples	S-MN-O-576
The Determination of Diesel Range Organics, Residual Range Organics and Total Extractable Hydrocarbons	S-MN-O-578
Preparation and Analysis of Samples for the Determination of Dioxins and Furans by USEPA Method 8290/8290A	S-MN-H-001
Preparation and Analysis of Samples for the Determination of 2,3,7,8-TCDD using USEPA Method 1613B, Drinking Water	S-MN-H-003
Preparation and Analysis of Samples for the Determination of PCDDs, PCDFs, and PCBs by modified USEPA Method 23, TO9, or NY State Guidelines	S-MN-H-005
Method 1668, PCB Congenger (WHO List)	S-MN-H-009
Preparation and Analysis of Samples for the Determination of Dioxins and Furans by 8280M	S-MN-H-013
Preparation and Analysis of Samples for the Determination of Chlorinated Biphenyl Congeners	S-MN-H-014
Preparation and Analysis of Samples for the Determination of Polybrominated Diphenyl Ether Congeners	S-MN-H-016
TCLP/SPLP	S-MN-I-312

ATTACHMENT VA- MINNEAPOLIS SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Inductively Coupled Plasma Atomic Emission Spectroscopy (RCRA)	S-MN-I-313
Hardness by Calculation	S-MN-I-338
Mercury in Liquid and Solid/Semis-Solid Waste	S-MN-I-359
Digest Procedure for Aqueous Samples to be Analyzed by Induct Coupled Plasma (SW-846)	S-MN-I-458
Metals Preparation for Solid samples, Wipes and Filters	S-MN-I-460
Metals Analysis by ICP/MS - Method 6020 and 200.8	S-MN-I-492
Preparation of Aqueous Samples for ICPMS Analysis	S-MN-I-523
Extractable Base/Neutral and Acid Organic Compounds in Liquid, Solid, and TCLP Matrices by Gas Chromatography/Mass Spectrometry Capillary Column Technique	S-MN-O-436
8270-L Extractable Base/Neutral and Acid Organic Compounds in Water and Liquid Matrices by GC/MS Capillary Column Technique w/Selective Ion Monitoring	S-MN-O-507
Extractable Base/Neutral and Acid Organic Compounds in Liquid by EPA Method 625	S-MN-O-532
Determination of Parent and Alkylated PAH Compounds in Solid and Liquid Matrices by GC/MS SIM	S-MN-O-561
Analysis of Air samples by GC/MS - Method TO-13	S-MN-O-534
Sulfolane Extraction and Analysis in Liquid Matrices by GCMS	S-MN-O-569
High Volume Injection for 8270C SIM	S-MN-O-570
Analysis of Volatile Organic Compounds by GC/MS Method 8260	S-MN-O-521
Analysis of Volatile Organic Compounds by GC/MS Method 624	S-MN-O-529
Analysis of Volatile Organic Compounds in Water Method 524.2	S-MN-O-546
Method For Sonicator Tuning	S-MN-O-414
Cleaning Glassware in the Organic Laboratory	S-MN-O-465
Sonication Extraction Technique for Base/Neutral and Acid Compounds (3550C Modified)	S-MN-O-495
Continuous Liquid-Liquid Extraction (SW3520) for Base/Neutral and Acid Compounds	S-MN-O-496
Spike Verification in the Organic Prep Lab	S-MN-O-497
Preparation of Anhydrous Sodium Sulfate for Extraction Purposes	S-MN-O-500
Nitrogen Evaporation Technique	S-MN-O-503
Sample Concentration Technique	S-MN-O-504
Separatory Funnel Extraction for Polyaromatic Hydrocarbons by 8270-SIM	S-MN-O-506
Solvent Exchange into Hexane	S-MN-O-509
Continuous Liq/Liq extraction for Method 8270C (Dual pH) by SW 3520C	S-MN-O-539
Soil Extraction for PAH Analysis by GC/MS:SIM (3550C)	S-MN-O-540
Separatory Funnel Extraction	S-MN-O-566
Data Archiving and Retrieval	S-MN-L-106
Reagent Water Quality	S-MN-L-110
Generation of EDD	S-MN-L-112
Preventative, Routine, and Non-routine Maintenance	S-MN-L-114
Receipt and Storage of Laboratory Supplies	S-MN-L-117
Data Review Process	S-MN-L-132
Syringe Technique	S-MN-L-139

ATTACHMENT VA- MINNEAPOLIS SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Procedure for Handling Aqueous Organic Extractable Samples Containing Sediment	S-MN-L-142
Purchasing Laboratory Supplies	S-MN-L-143
Laboratory Housekeeping	S-MN-L-145
Sample Homogenization and Sub-Sampling	S-MN-L-147
Quality Manual	17.1
Control Chart Generation and Trend Analysis	S-MN-Q-205
Manual Integration	S-MN-Q-214
Control of Hazardous Energy Program - Lockout/Tagout	S-MN-Q-249
Method Validation and Modification Studies	S-MN-Q-252
Procedure for Handling of USDA regulated soils	S-MN-Q-253
Estimation of Measurement Uncertainty	S-MN-Q-255
Management of Change	S-MN-Q-257
Proficiency Testing Program	S-MN-Q-258
Evaluation and Qualification of Vendors	S-MN-Q-259
Use of A2LA Terms and Symbols	S-MN-Q-260
Conflict of Interest Plan	S-MN-Q-261
Corrective and Preventative Actions	S-MN-Q-262
Monitoring Temperature Controlled Units	S-MN-Q-263
Support Equipment	S-MN-Q-264
Document Control and Management	S-MN-Q-268
Determination of Limit of Detection and Limit of Quantitation	S-MN-Q-269
Review of Analytical Requests	S-MN-Q-270
Internal and External Audits	S-MN-Q-271
MCL Violation Reporting	S-MN-Q-272
Preparation of Standard Operating Procedures	S-MN-Q-273
Spreadsheet Validation	S-MN-Q-274
Standard and Reagent Management and Traceability	S-MN-Q-275
Use of the Pacelink System	S-MN-Q-276
Chemical Hygiene Plan/Safety Manual	S-MN-S-001
Waste Management Training Requirements	S-MN-S-002
Waste Handling and Management	S-MN-S-003
MN Contingency Plan	2014
Air Quality Monitoring and Fume Hood Monitoring	S-MN-S-004
Biochemical Oxygen Demand (BOD) and Carbonaceous Biochemical Oxygen Demand (CBOD)	S-MN-I-348
Determination of Hexane Extractable material (HEM) and Silica Gel Treated – Hexane Extractable Material (SGT-HEM) in Solids	S-MN-I-357
Hexavalent Chromium in Water and Wastewater	S-MN-I-358
Alkalinity, Titrimetric	S-MN-I-365
Fluoride in Water and Wastewater	S-MN-I-470

ATTACHMENT VA- MINNEAPOLIS SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Determination of Total Phosphorus in Aqueous Samples by SmartChem	S-MN-I-473
Specific Conductivity	S-MN-I-474
Ortho Phosphorus in Water by the Konelab, Ascorbic Acid Method	S-MN-I-477
Settleable Solids	S-MN-I-486
Standard Test Method for Screening Apparent Specific Gravity and Bulk Density Waste	S-MN-I-493
Determination of Total Recoverable Phenolics by Flow Injection Colorimetry	S-MN-I-494
Turbidity	S-MN-I-501
Chlorine, Total Residual in Water	S-MN-I-502
Use and Maintenance of the Konelab	S-MN-I-507
Determination of Nitrate/Nitrite in Surface and Wastewater by SmartChem Colorimetric Analysis	S-MN-I-508
Determination of Chloride by Konelab	S-MN-I-509
Determination of Sulfate by Konelab	S-MN-I-510
Determination of Nitrite by Konelab (Spectrophotometric Method)	S-MN-I-514
Paint Filter Liquids Test	S-MN-I-516
Determination of Hexane Extractable material (HEM) and Silica Gel Treated – Hexane Extractable Material (SGT-HEM) in Water	S-MN-I-520
Dissolved Oxygen	S-MN-I-524
Measurement of pH in Water, Soil, and Waste	S-MN-I-526
Determination of TSP and PM 10	S-MN-I-527
Measurement of Solids in Water and Wastewater	S-MN-I-528
Total CN in Water - Macro Distillation	S-MN-I-529
Weak Acid Disociable Cyanide in Water - Macro Distillation	S-MN-I-530
Total Coliform Bacteria	S-MN-MB-001
Fecal Coliform by MF	S-MN-MB-002
Heterotrophic Plate Count	S-MN-MB-003
Total Coliform Bacteria by Membrane Filtration	S-MN-MB-005
Sample Container Sterility Verification	S-MN-MB-006
Total Coliform Bacteria and E. Coliform Bacteria	S-MN-MB-007
The Determination of Ammonia by SmartChem	S-MN-I-559
Determination of NO3/NO2 by SmartChem	S-MN-I-560
Data Correctness Calculations	S-MN-I-562
COD by Hach 2700	S-MN-I-563
Total Recoverable Cyanide and Amenable Cyanide in Water	S-MN-I-564
Delta Airlines Anodizing Line	S-MN-I-582
Determination of Inorganic Anions by Ion Chromatography	S-MN-I-583
Determination of Nitrate/Nitrite on the Lachat by Cadmium Reduction	S-MN-I-584
Determination of Sulfate on the Lachat	S-MN-I-585
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Net Acid Generation (NAG)	S-MN-I-589

ATTACHMENT VA- MINNEAPOLIS SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Humidity Cells	S-MN-I-590
Determination of Phenolic Compounds by Flow Injection Analysis Colorimetry	S-MN-I-591
Determination of Chloride by Flow Injection Analysis Colormetry	S-MN-I-592
Determination of Ortho Phosphate in Waters by Flow Injection Analysis Colorimetry	S-MN-I-593
Determination of Hexavalent Chromium by Flow Injection Analysis	S-MN-I-594
Drierite Regeneration Procedure	S-MN-O-557
Bottle Order Database	S-ALL-C-002
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EPIC PRO: Acode Addition/Modification	S-ALL-Q-008
Laboratory Documentation	S-ALL-Q-009
Quarterly Quality Report	S-ALL-Q-014
Review of Laboratory Management System	S-ALL-Q-015
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3P Program: CIP	S-ALL-Q-022
Use and Operation of Lab Track System	S-ALL-Q-028
Mint Miner Data File Review	S-ALL-Q-029
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Processing Tentatively Identified Compounds (TICS) for GC/MS	S-ALL-O-038
Hazard Assessments	S-ALL-S-001
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ATTACHMENT VB- MONTANA SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

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Microscope Alignment - Polarized Light Microscope	S-MT-ASB-016
Bulk Analysis Using Polarized Light Microscopy	S-MT-ASB-023
Asbestos Data Review	S-MT-ASB-026
Fiber Counts By NIOSH 7400 Using Excel Spreadsheet	S-MT-ASB-027
Quality Control for Asbestos Analysis	S-MT-ASB-028
The Determination of Extractable Petroleum Hydrocarbons by Method MA-EPH	S-MT-O-001
Petroleum Hydrocarbons as Diesel in Water and Soil	S-MT-O-002
Purgeable Total Petroleum Hydrocarbons in Water and Soil	S-MT-O-003
Volatile Petroleum Hydrocarbons (VPH)	S-MT-O-005
Coarse Fragment	S-MT-ME-035
Acid-Base Accounting - Sobek	S-MT-ME-004
pH Paste	S-MT-ME-006
Soil Sieve for Black Eagle	S-MT-ME-017
Organic Matter	S-MT-ME-001
Available Nitrate and Ammonia	S-MT-ME-022
Particle Size Analysis	S-MT-ME-024
Volatile Organic Compounds by 8260B	S-MT-O-004
Preparation of Anhydrous Sodium Sulfate for Extraction Purposes	S-MT-O-008
Referencing NVLAP Accreditation	S-MT-Q-001
MT Contingency plan	2014
Waste Handling and Management	S-MT-S-001
Nitrite by SM4500 NO2B	S-MT-I-036
Acidity	S-MT-I-032
Turbidity	S-MT-I-034
Phosphorus, Ortho and Total	S-MT-I-002
Sulfides	S-MT-I-005
Specific Conductivity SW2510B	S-MT-I-007
Measurement of Solids in Water and Wastewater	S-MT-I-008
The Determination of Nitrate-Nitrite by Flow Analyzer	S-MT-I-009
TKN By Colorimetry	S-MT-I-010
Total Sufur by LECO	S-MT-ME-012
Water Soluble Sulfate and Chloride	S-MT-I-013
The Determination of Percent Moisture in Soil and Solid Samples	S-MT-I-014
Determination of Inorganic Anions by Ion Chromatography	S-MT-I-018
Determination of Ammonia Nitrogen by Automated Phenate	S-MT-I-019
Chlorophyll-a	S-MT-I-020

ATTACHMENT VB- MONTANA SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Measurement of pH in Water, Soil, and Waste	S-MT-I-021
Determination of Oxidation-Reduction Potential in Water	S-MT-I-029
Settleable Solids	S-MT-I-030
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Multi Increment Soil Sampling	S-MT-I-033
Soil Agronmy Metals Extraction Procedures	S-MT-M-032
Inductively Coupled Plasma Atomic Emission Spectroscropy	S-MT-M-033

ATTACHMENT VC- VIRGINIA SOP LIST (CURRENT AS OF ISSUE DATE)

Title	SOP Number
Sample Management	S-VM-C-001
Bottle Preparation	S-VM-C-002
Subcontracting Samples	S-VM-C-003
Alkalinity, Titrimetric (Automated Titration)	S-VM-I-002
Acidity Titration Method	S-VM-I-003
Conductivity	S-VM-I-005
Turbidity	S-VM-I-006
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Total Residual Chlorine	S-VM-I-008
Chlorine Automated Ferricyanide Method	S-VM-I-009
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Measurement of Solids in Water and Wastewater	S-VM-I-011
Determination of Hexavalent Chrome by Colorimetric Analysis	S-VM-I-012
Determination of Phosphorus by Automated Colorimetry	S-VM-I-013
Determination of Orthophosphate by Colorimetry	S-VM-I-014
Ammonia-Nitrogen by Semi-Automated Colorimetry	S-VM-I-015
Total Kjeldahl Nitrogen by Semi-Automated Colorimetry	S-VM-I-016
Nitrogen, NO3+NO2 and NO2 by EPA 353.2 Colorimetric, Automated	S-VM-I-017
Determination of Anions by Ion Chromatography	S-VM-I-018
Total Organic Carbon and Dissolved Organic Carbon	S-VM-I-019
Determination of Chemical Oxygen Demand in Water, Wastewater and Industrial Wastes Using the Hach Spectrophotometer	S-VM-I-020
Biochemical Oxygen Demand and Carbonaceous Biochemical Oxygen Demand	S-VM-I-021
Total and Fecal Coliform Bacteria Membrane Filter	S-VM-I-022
Total Coliform Bacteria	S-VM-I-023
Heterotropic Plate Count Simplate Procedure	S-VM-I-024
Sample Container Sterility Verification	S-VM-I-025
Total Coliform Bacteria and E Coliform Bacteria	S-VM-I-026
Chlorophyll A	S-VM-I-027
Formaldehyde	S-VM-I-028
The Determination of Cation Anion Balance	S-VM-I-029
Determination of Percent Total Solids	S-VM-I-031
Total Amine Analysis in Water by Spectrometry	S-VM-I-032
Total Sulfide, Iodometric Titration	S-VM-I-033
The Determination of Oxidation Reduction Potential (ORP)	S-VM-I-034
Determination of Metals by Inductively Coupled Plasma (ICP) Spectroscopy	S-VM-M-001
Mercury in Liquid and Solid/Semi-Solid Waste	S-VM-M-004
Metals Analysis by ICP/MS	S-VM-M-006

ATTACHMENT VC- VIRGINIA SOP LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Determination of Selenium, Total and Speciated, in Liquid and Soil by Hydride Generation	S-VM-M-008
The Determination of Moisture, Ash, and Organic Matter of Peat and Other Organic Soils (Mining)	S-VM-MIN-001
Size Analysis Using Sieves (Mining)	S-VM-MIN-002
Mechanical Hydrometer / Grain Size Analysis (Mining)	S-VM-MIN-003
Filtering Slurry Samples for Metals Analysis (Mining)	S-VM-MIN-004
Digestion of Samples for Metals Analysis ASTM E507-93(Mining)	S-VM-MIN-005
Digestion of Samples for Metals Analysis Internal Digestion Method(Mining)	S-VM-MIN-006
The Pulverization of Ore and Solid Matrices (Mining)	S-VM-MIN-007
Atterberg Limits (Mining)	S-VM-MIN-008
Determination of Ferrous Iron in D.R.I. Iron Ore and Concentrates Dichromate Method Manual Titration (Mining)	S-VM-MIN-010
Flashpoint: Closed Cup (Mining)	S-VM-MIN-011
Visual Soil Classification (Mining)	S-VM-MIN-012
Moisture in the Analysis Sample of Coal and Coke (Mining)	S-VM-MIN-013

ATTACHMENT VD- DULUTH SOP LIST (CURRENT AS OF ISSUE DATE)

Title	SOP Number
Mercury Analysis by Cold Vapor Atomic Fluorescence Spectrometry	S-VM-M-003
Methyl Mercury Analysis by Aqueous Ethylation, Purge and Trap GC with CVAFS Detection	S-VM-M-007
Mercury Analysis by Cold Vapor Atomic Fluorescence Spectrometry of Solid Samples	S-VM-M-010

ATTACHMENT VIa- MINNEAPOLIS CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

SCOPE AND APPLICATION CERTIFICATES ARE MAINTAINED AND FILED IN THE LOCAL QUALITY DEPARTMENT

EPA ID: MN00064

State	Agency	Program	Cert #	Expiration
A2LA	A2LA	DW – Dioxin, WW, HZ; Envi – WW. HZ; Air; DOD	2926.01	10/31/2015
Alabama	Dept of Environmental Mgmt	Dioxin - DW	40770	12/31/2014
Alaska	Dept. of Environmental Conservation	Contaminated Sites (6010B, 6020, 8260B, PCBs, PAHs)	UST-078	8/10/2014
Alaska	Dept. of Environmental Conservation	Dioxin - DW	MN00064	6/30/2014
Arizona	Dept of Health Services	Dioxin/Envi -DW, WW, HW; Air	AZ0014	12/14/2014
Arkansas	Dept of Environmental Quality	Dioxins/Env	88-0680	6/19/2014
California	Dept of Health Services	Dioxin/Envi -DW, WW, HW	01155CA	8/31/2014
Colorado	Dept. of Public Health & Environment	Dioxins/Envi – DW	Pace Analytical	12/31/2014
Connecticut	Dept of Public Health	Dioxin/Envi -DW, WW, HW	PH-0256	12/31/2014
EPA Region 8 - Wyhoming	Water Division	Dioxins/Envi – DW	8TMS	12/31/2014
Florida (NELAP)	Dept of Health Services	Dioxin/Envi -DW, WW, HW; Air	E87605	6/30/2014
Georgia	Environmental Protection Division	Dioxin/Envi - WW, HW	Pace	12/31/2014
Georgia	Dept of Natural Resources	Dioxin - DW	959	12/31/2014
Guam	Guam EPA	Dioxin - DW	Pace Analytical	10/21/2014
Idaho	Dept. of Health & Welfare	Dioxins/Envi – DW	MN00064	12/31/2014
Hawaii	Dept of Health	Dioxins/Envi – DW	MN00064	12/31/2014
Illinois	Illinois EPA	Dioxin/Envi - DW, HW, WW	200011	12/11/2014
Indiana	Dept of Health	Dioxin - DW	C-MN-01	12/31/2014
Iowa	Dept.of Natural Resources	Dioxin - DW	368	6/1/2015
Kansas	Dept of Health and Environment	Dioxin/Envi - DW, WW, HW	E-10167	10/31/2014
Kentucky	Dept of Environmental Protection	Dioxin – DW	90062	12/31/2014
Kentucky	Dept of Environmental Protection	Dioxin – WW	90062	12/31/2014
Louisiana DEQ	Department of Environmental Quality	Dioxin/Envi - WW, HW; Air	3086	6/30/2014
Louisiana DHH	Department of Health and Hospitals	Dioxin – DW	LA140001	12/31/2014
Maine	Dept of Human Services	Dioxin/Envi - DW	2013011	5/27/2015
Maryland	Dept. of Heath and Mental Hygiene	Dioxin/Envi - DW	322	6/30/2015
Michigan	Dept. of Public Health	Dioxin/Envi - DW	9909	12/31/2014
Minnesota	Dept of Health	Envi - DW, WW, HW	027-053-137	12/31/2014
Minnesota	Department of Commerce	Petrofund	1240	4/16/2014

ATTACHMENT VIA- MINNEAPOLIS CERTIFICATION LIST CONTINUED (CURRENT AS OF ISSUE DATE)

Mississippi	Dept. of Health and Environmental Control	Dioxin - DW	Pace	12/31/2014
Montana	Dept of Health	Dioxin/Envi - DW	92	1/1/2015
Nebraska	Dept. of Health & Human Services.	Dioxin /Envi - DW	Pace	12/31/2014
Nevada	Health Division	Dioxin/Envi - DW, WW, HW	MN_00064_2000_72	7/31/2014
New Jersey	Dept of Environmental Protection	Dioxin/Envi - DW, WW, HW	MN002	6/30/2014
New York	Dept of Health	Dioxin - DW, WW, Air	11647	4/1/2015
North Carolina	Dept of Environment, Health and Natural Resources	Envir - WW, HW	530	12/31/2014
North Carolina	State Public Health Laboratory	Dioxin - DW	27700	7/31/2014
North Dakota	Dept of Health and Consolidated Labs	Dioxin/Envi - DW, WW, HW	R-036	12/31/2014
Ohio	Ohio EPA	Dioxin - DW	4150	12/31/2014
Ohio Vap	VAP	Air	CL101	1/29/2016
Oklahoma	Dept of Environmental Quality	Dioxin/Envi - DW	9507	8/31/2014
Oregon	ELAP	Dioxin - DW, WW, HW; Air	MN200001-005	8/14/2015
Oregon	ELAP	NwTPH	MN300001-001	5/25/2015
Pennsylvania	Dept of Environmental Protection	Dioxin/Envi - DW, WW, HW	68-00563	3/31/2015
Puerto Rico	Departamento de Salud	Dioxin /Envi – DW		1/30/2015
Saipan (CNMI)	Div. Of Environmental Quality	Dioxin - DW	MP0003	12/31/2014
South Carolina	Dept. of Health and Environmental Control	Dioxin - DW, WW, HW	74003001	12/31/2014
Texas	Department of Health	Dioxin/Envi -DW, WW, HW; Air	T104704192	2/28/2015
Tennessee	Dept of Health	Dioxin/Envi -DW	TN02818	12/31/2014
Utah	Department of Health	Dioxin/Envi - DW, WW, HW	MN00064	6/30/2014
Virginia	Dept of General Services	Dioxin- DW	251	6/30/2014
Virginia - ELAP	VELAP	Dioxin/Envi - DW, WW, HW	460163	6/14/2015
Washington	Dept of Ecology	Dioxin/Envi -DW, WW, HW; Air	C486	2/18/2015
Wisconsin	Dept of Natural Resources	Dioxin/Envi - DW, WW, HW	999407970	8/31/2014
Wyoming	Via EPA Region 8	Dioxin/Envir - DW	8TMS-L	12/31/2014
West Virginia	Dept of Env. Protection	Envi/Dioxin - HW, WW	382	8/31/2014
West Virginia	Dept of Health and Human Resources	Dioxin - DW	9952C	12/31/2014

ATTACHMENT VIB- MONTANA CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

EPA ID: MT00012

State	Agency	Program	Cert #	Expiration
A2LA	A2LA	Envi – DW, WW. HZ	2926.01	10/31/2015
Colorado	Dept. of Public Health & Environment	Asbestos Registration	17119	3/15/2015
EPA Region 8	Water Division	DW	8TMS-L	12/31/2014
Idaho	Dept. of Health & Welfare	DW	MT00012	12/31/2014
Minnesota	Dept of Health	Envi-DW, WW	11610AA	12/31/2014
Montana	Dept of Health	DW	40	12/31/2015
North Dakota	Dept of Health and Consolidated Labs	Envi-DW, WW, HW	R-209	12/31/2014
NVLAP	NVLAP	Asbestos	101292-0	3/31/2015
Washington	Dept. of Ecology	DW, NPW,SCM	C993	11/15/2014

ATTACHMENT VIC-VIRGINIA CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

EPA ID: MN01084

State	Agency	Program	Cert #	Expiration
Alaska	Dept. of Environmental Conservation	Contaminated Sites (6010B, 6020)	UST-078	8/10/2014
Alaska	Dept. of Environmental Conservation	DW	MN01084	6/30/2014
Arizona	Dept. of Health Services	Envi-DW, WW, HW (TOC)	AZ0785	9/9/2014
Minnesota	Dept. of Health	Envi-DW, WW, HW	027-137-445	12/31/2014
North Dakota	Dept. of Health	Envi-DW, WW, HW	R-203	12/31/2014
Washington	Dept. of Ecology	WW, HZ - TOC	C1007	3/23/2015
Wiscousin	Dept. of Natural Resources	Envi-WW, HW	998027470	8/31/2014

ATTACHMENT VID- DULUTH CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

EPA ID: MN01085

State	Agency	Program	Cert #	Expiration
Minnesota	Dept. of Health	Dioxin-WW; Micro-SDW	027-137-446	12/31/2014
Wisconsin	Dept. of Natural Resources	Envi-WW (Hg)	399066580	8/31/2014

ATTACHMENT VII- PACE CHAIN-OF-CUSTODY (CURRENT AS OF ISSUE DATE)

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

Section A **Required Client Information:**	**Section B** **Required Project Information:**	**Section C** Invoice Information:
Company:	Report To:	Attention:
Address:	Copy To:	Company Name:
		Address:
Email To:	Purchase Order No.:	Pace Quote Reference:
Phone: Fax:	Project Name:	Pace Project Manager:
Requested Due Date/TAT:	Project Number:	Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ROUND WATER D☐NKING WATER

☐ UST ☐RA OTH☐ ______

Site Location

STATE: ______

Section D
Required Client Information

Matrix Codes
MATRIX / CODE

Drinking Water	DW
Water	WT
Waste Water	WW
Product	P
Soil/Solid	SL
Oil	OL
Wipe	WP
Air	AR
Tissue	TS
Other	OT

ITEM #	**SAMPLE ID** (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED: COMPOSITE START DATE	COLLECTED: COMPOSITE START TIME	COLLECTED: COMPOSITE END/GRAB DATE	COLLECTED: COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	*Preservatives*: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	⬇ Analysis Test ⬆ Y/N	Requested Analysis Filtered (Y/N)												Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1																																
2																																
3																																
4																																
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12																																

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER:

DATE Signed (MM/DD/YY):

ATTACHMENT VIII- METHOD HOLD TIME, CONTAINER AND PRESERVATION GUIDE (CURRENT AS OF ISSUE DATE)

THE HOLDING TIME INDICATED IN THE CHART BELOW IS THE MAXIMUM ALLOWABLE TIME FROM COLLECTION TO EXTRACTION AND/OR ANALYSIS PER THE ANALYTICAL METHOD. FOR METHODS THAT REQUIRE PROCESSING PRIOR TO ANALYSIS, THE HOLDING TIME IS DESIGNATED AS 'PREPARATION HOLDING TIME/ANALYSIS HOLDING TIME'.

Parameter	**Method**	**Matrix**	**Container**	**Preservative**	**Max Hold Time**	**Additional Volume for MS/MSD**
Acidity	SM2310B	Water	Plastic/Glass	$\leq 6^\circ$C	14 Days	
Actinides	HASL-300	Water		pH<2 HNO_3	180 Days	
Actinides	HASL-300	Solid		None	180 Days	
Alkalinity	SM2320B/310.2	Water	Plastic/Glass	$\leq 6^\circ$C	14 Days	
Alkylated PAHs		Water		$\leq 6^\circ$C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	Yes
Alkylated PAHs		Solid		$\leq 10^\circ$C	1 Year/40 Days	
Total Alpha Radium (see note 3)	9315/903.0	Water	Plastic/Glass	pH<2 HNO_3	180 days	
Total Alpha Radium (see note 3)	9315	Solid		None	180 days	
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0/300.1/SM 4110B	Water	Plastic/Glass	$\leq 6^\circ$C; EDA if bromate or chlorite run	All analytes 28 days except: NO_2, NO_3, o-Phos (48 Hours); chlorite (immediately for 300.0; 14 Days for 300.1). NO_2/NO_3 combo 28 days.	Yes
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4, bromate, chlorite, chlorate)	300.0	Solid	Plastic/Glass	$\leq 6^\circ$C	All analytes 28 days except: NO_2, NO_3, o-Phos (48 hours); chlorite (immediately). NO_2/NO_3 combo 28 days.	
Anions (Br, Cl, F, NO_2, NO_3, o-Phos, SO_4	9056	Water/ Solid	Plastic/Glass	$\leq 6^\circ$C	28 days	
Aromatic and Halogenated Volatiles (see note 1)	8021	Solid	5035 vial kit	See note 1	14 days	Yes
Aromatic and Halogenated Volatiles	602/8021	Water	40mL vials	pH<2 HCl; $\leq 6^\circ$C; $Na_2S_2O_3$ if Cl present	14 Days (7 Days for aromatics if unpreserved)	
Acid Volatile Sulfide	Draft EPA 1629	Solid	8oz Glass	$\leq 6^\circ$C	14 Days	
Bacteria, Total Plate Count	SM9221D	Water	Plastic/WK	$\leq 6^\circ$C; $Na_2S_2O_3$	24 Hours	Yes
Base/Neutrals and Acids	8270	Solid	8oz Glass	$\leq 6^\circ$C	14/40 Days	

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
Base/Neutrals and Acids	625/8270	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days	Yes
Base/Neutrals, Acids & Pesticides	525.2	Water	1L Amber Glass	pH<2 HCl; ≤ 6°C; Na sulfite if Cl present	14/30 Days	Yes
Biomarkers		Water	≤ 6°C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	≤ 6°C; pH<2 1:1 HCl (optional)	Yes
Biomarkers		Solid	≤ 10°C	1 Year/40 Days	≤ 10°C	
BOD/cBOD	SM5210B	Water	Plastic/Glass	≤ 6°C	48 hours	Yes
BTEX/Total Hydrocarbons	TO-3	Air	Summa Canister	None	14 Days	
BTEX/Total Hydrocarbons	TO-3	Air	Tedlar Bag or equivalent	None	48 Hours	
Carbamates	531.1	Water	Glass	$Na_2S_2O_3$, Monochloroacetic acid pH <3; ≤ 6°C	28 Days	
Cation/Anion Balance	SM1030E	Water	Plastic/Glass	None	None	
Cation Exchange	9081	Solid	8oz Glass	None	unknown	
Chloride	SM4500Cl-C,E	Water	Plastic/Glass	None	28 Days	Yes
Chlorine, Residual	SM4500Cl-D,E,G/330.5/Hach 8167	Water	Plastic/Glass	None	15 minutes	
Chlorophyll	SM10200H	Water	Opaque bottle or aluminum foil	≤ 6°C	48 Hours to filtration	
COD	SM5220C, D/410.4/Hach 8000	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days	Yes
Coliform, Fecal	SM9222D	Water	100mL Plastic	≤ 6°C	8 Hours	
Coliform, Fecal	SM9222D	Solid	100mL Plastic	≤ 6°C	8 Hours	
Coliform, Fecal	SM9221E	Water	100mL Plastic	≤ 6°C	8 Hours	
Coliform, Fecal	SM9221E	Solid	100mL Plastic	≤ 6°C	24 Hours	
Coliform, Total	SM9222B	Water	100mL Plastic	≤ 6°C	8 Hours	
Coliform, Total	SM9221B	Solid	100mL Plastic	≤ 6°C	8 Hours	
Coliform, Total and E. coli	SM9223B	Drinking Water	100mL Plastic	≤ 10°C	30 Hours after collection	
Color	SM2120B,E	Water	Covered Plastic/Acid Washed Amber Glass	≤ 6°C	24 Hours	
Condensable Particulate Emissions	EPA 202	Air	Solutions	None	180 Days	
Cyanide, Reactive	SW846 chap.7	Water	Plastic/Glass	None	28 Days	
Cyanide, Reactive	SW846 chap.7	Solid	Plastic/Glass	None	28 Days	
Cyanide, Total and	SM4500CN-	Water	Plastic/Glass	pH≥12 NaOH;	14 Days	Yes

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Water	1L Amber Glass	pH<2 HCl; ≤ 6°C	14/40 Days	
Extractable Petroleum Hydrocarbons (aliphatic and aromatic)	MA-EPH	Solid	4oz Glass Jar	≤ 6°C	7/40 Days	
Fecal Streptococci	SM9230B	Water	100mL Plastic	≤ 6°C	8 Hours	
Ferrous Iron	SN3500Fe-D; Hach 8146	Water	Glass	None	Immediate	
Flashpoint/ Ignitability	1010	Liquid	Plastic/Glass	None	28 Days	
Florida PRO	FL PRO DEP (11/1/95)	Liquid	Glass, PTFE lined cap	≤ 6°C; pH <2 H_2SO_4 or HCl	7/40 Days	
Fluoride	SM4500Fl-C,D	Water	Plastic	None	28 Days	Yes
Gamma Emitting Radionuclides	901.1	Water	Plastic/Glass	pH<2 HNO_3	180 days	
Gasoline Range Organics	8015	Water	40mL vials	pH<2 HCl	14 Days	Yes
Gasoline Range Organics	8015	Solid	5035 vial kit	See note 1	14 days	
Gasoline Range Organics- Alaska GRO	AK101	Solid	5035 vial kit	See 5035 note*	28 Days if GRO only (14 Days with BTEX)	Yes
Gasoline Range Organics- Alaska GRO	AK101	Water	40mL vials	pH<2 HCl; ≤ 6°C	14 Days	Yes
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Water	40mL vials	pH<2 HCl; ≤ 6°C	7 Days unpreserved; 14 Days preserved	Yes
Gasoline Range Organics- NwTPH-Gx	Nw-TPH-Gx	Solid	40mL vials	≤ 6°C; packed jars with no headspace	14 Days	Yes
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Water	40mL vials	pH<2 HCl; ≤ 6°C	14 Days	
Gasoline Range Organics- Wisconsin GRO	WI MOD GRO	Solid	40mL MeOH vials	≤ 6°C in MeOH	21 Days	
Glyphosate	547	Water	Glass	≤ 6°C; $Na_2S_2O_3$	14 Days (18 Months frozen)	
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6	Water	Plastic/Glass	pH<2 HNO_3	48 Hrs	
Gross Alpha and Gross Beta	9310/900.0	Water	Plastic/Glass	pH<2 HNO_3	180 Days	
Gross Alpha and Gross Beta	9310	Solid	Glass	None	180 Days	

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
Haloacetic Acids	552.1/552.2	Water	40mL Amber vials	NH_4Cl; $\leq 6^{\circ}C$	14/7 Days if extracts stored $\leq 6^{\circ}C$ or 14/14 Days if extracts stored at $\leq -10^{\circ}C$	Yes
Hardness, Total ($CaCO_3$)	SM2340B,C/ 130.1	Water	Plastic/Glass	pH<2 HNO_3	6 Months	
Heterotrophic Plate Count (SPC/HPC)	SM9215B	Water	100mL Plastic	$\leq 6^{\circ}C$	24 Hours	
Heterotrophic Plate Count (SPC/HPC)	SimPlate	Water	100mL Plastic	$\leq 6^{\circ}C$	8 Hours	
Herbicides, Chlorinated	8151	Solid	8oz Glass Jar	$\leq 6^{\circ}C$	14/40 Days	
Herbicides, Chlorinated	8151	Water	1L Amber Glass	$\leq 6^{\circ}C$; $Na_2S_2O_3$ if Cl present	7/40 Days	Yes
Herbicides, Chlorinated	515.1/515.3	Water	1L Amber Glass	$\leq 6^{\circ}C$; $Na_2S_2O_3$ if Cl present	14/28 Days	Yes
Hexavalent Chromium	7196/218.6/ SM3500Cr-B, C, D	Water	Plastic/Glass	$\leq 6^{\circ}C$	24 Hours (see note 4)	Yes
Hexavalent Chromium	7196/218.6/ SM3500Cr-B, C, D	Water	Plastic/Glass	Ammonium Buffer pH 9.3-9.7	28 Days (see note 4)	Yes
Hexavalent Chromium	218.6/218.7	Drinking Water	Plastic/Glass	Ammonium Buffer pH >8	14 Days (see note 4)	
Hexavalent Chromium	7196 (with 3060A)	Solid		$\leq 6^{\circ}C$	24 Hours after extraction	
Hydrogen Halide and Halogen Emissions	EPA 26	Air	Solutions	None	6 Months	
Ignitability of Solids	1030	Non-liquid Waste	Plastic/Glass	None	28 Days	
Lead Emissions	EPA 12	Air	Filter/Solutions	None	6 Months	
Lipids	Pace Lipids	Tissue	Plastic/Glass	$\leq -10^{\circ}C$	1 Year if frozen	
Mercury, Low-Level	1631E	Solid	Glass	None	28 Days	
Mercury, Low-Level	1631E	Water	Fluoropolymer bottles (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 Hours for preservation or analysis; 28 Days to preservation if sample oxidized in bottle; 90 Days for analysis if preserved	Yes
Mercury, Low-Level	1631E	Tissue	Plastic/Glass	$\leq -10^{\circ}C$	28 Days if frozen	
Mercury, Methyl	1630	Water	Teflon/fluoropolymer or Glass	4 mL/L HCl for fresh water, 2 mL/L H2SO4 for saline samples, or fill to the top	6 months if preserved; Distillate – one week if refrigerated; Ethylated distillate –	Yes

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
				with sample so there is no headspace and maintain 0-4 oC until preservation	analyze within 48 hours; Or the samples must be acid preserved within 48 hours of sampling	
Mercury	7471	Solid	8oz Glass Jar	≤ 6°C	28 Days	
Mercury	7470/245.1/ 245.2	Water	Plastic/Glass	pH<2 HNO_3	28 Days	Yes
Mercury	7471/245.6	Tissue	Plastic/Glass	≤ - 10°C	28 Days if frozen	
Metals (GFAA)	7000/200.9	Water	Plastic/Glass	pH<2 HNO_3	180 Days	
Metals (ICP)	NIOSH 7300A/7303	Air	Filters	None	180 Days	
Metals (ICP/ICPMS)	6010/6020	Solid	8oz Glass Jar	None	180 Days	
Metals (ICP/ICPMS)	6010/6020/ 200.7/200.8	Water	Plastic/Glass	pH<2 HNO_3	180 Days	
Metals (ICP/ICPMS)	6020	Tissue	Plastic/Glass	≤ -10°C	180 Days if frozen	
Methane, Ethane, Ethene	8015 modified	Water	40mL vials	HCl	14 Days	Yes
Methane, Ethane, Ethene	RSK-175	Water	40mL vials	unpreserved	7 Days	Yes
Methane, Ethane, Ethene	EPA 3C	Air	Summa Canister	None	14 Days	
Methane, Ethane, Ethene	EPA 3C	Air	Tedlar Bag or equivalent	None	48 Hours	
Methanol, Ethanol	8015 modified	Water	40mL vials	≤ 6°C	14 Days	Yes
Methanol, Ethanol	8015 modified	Solid	2oz Glass	≤ 6°C	14 Days	
Nitrogen, Ammonia	SM4500NH3/ 350.1	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days	Yes
Nitrogen, Kjeldahl (TKN)	351.2	Solid	Plastic/Glass	≤ 6°C	28 Days	
Nitrogen, Kjeldahl (TKN)	SM4500-Norg/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days	Yes
Nitrogen, Nitrate	SM4500-NO3/ 352.1	Water	Plastic/Glass	≤ 6°C	24 Hours preferred	Yes
Nitrogen, Nitrate & Nitrite combination	353.2	Solid	Plastic/Glass	≤ 6°C	28 Days	
Nitrogen, Nitrate & Nitrite combination	SM4500-NO3/ 353.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days	Yes
Nitrogen, Nitrite or Nitrate separately	SM4500-NO2/ 353.2	Water	Plastic/Glass	≤ 6°C	48 Hours	Yes
Nitrogen, Organic	SM4500-Norg/ 351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤ 6°C	28 Days	Yes
Non-Methane Organics	EPA 25C	Air	Summa Canister	None	14 Days	
Non-Methane Organics	EPA 25C	Air	Tedlar Bag or equivalent	None	48 Hours	

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
Odor	SM2150B	Water	Glass	≤ 6°C	24 Hours	
Oil and Grease/HEM	1664A/ SM5520B/9070	Water	Glass	pH<2 H_2SO_4 or HCl; ≤ 6°C	28 Days	Yes
Oil and Grease/HEM	9071	Solid	Glass	≤ 6°C	28 Days	
PBDEs	1614	Water	1L Amber Glass	≤ 6°C	1 Year/1 Year	Yes
PBDEs	1614	Solid	Wide Mouth Jar	≤ 6°C	1 Year/1 Year	
PBDEs	1614	Tissue	Aluminum Foil	≤ -10°C	1 Year/1 Year	
PCBs and Pesticides, Organochlorine (OC)	TO-4/TO-10	Air	PUF	None	7/40 Days	
PCBs and Pesticides, Organochlorine (OC)	608	Water	1L Amber Glass		Pest: 7/40 Days; PCB: 1 Year/1 Year	
PCBs, Pesticides (OC), Herbicides	508.1	Water	Glass	Na2SO3; pH<2 HCl; < 6°C	14/30 Days	
Perchlorate	331	Water	Plastic/Glass	>0-6°C	28 Days	
Pesticides, Organochlorine (OC)	8081	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days	
Pesticides, Organochlorine (OC)	8081	Solid	8oz Glass Jar	≤ 6°C	14/40 Days	
Pesticides, Organochlorine (OC)	8081	Tissue	8oz Glass Jar	≤ -10°C	1 Year if frozen/40 Days	
Pesticides, Organophosphorous (OP)	8141	Solid	8oz Glass Jar	≤ 6°C	14/40 Days	
Pesticides, Organophosphorous (OP)	8141	Water	1L Amber Glass	pH 5-8 with NaOH or H_2SO_4; ≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days	Yes
PCBs (Aroclors)	8082	Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	1 Year/1 Year	Yes
PCBs (Aroclors)	8082	Solid	8oz Glass Jar	≤ 6°C	1 Year/1 Year	
PCBs (Aroclors)	8082	Tissue	Plastic/Glass	≤ -10°C	1 Year if frozen/1 Year	
PCB Congeners	1668A	Water	1L Amber Glass	≤ 6°C but above freezing	1 Year/1 Year	Yes
PCB Congeners	1668A	Solid	4-8oz Glass Jar	≤ 6°C but above freezing	1 Year/1 Year	
PCB Congeners	1668A	Tissue	4-8oz Glass Jar	≤ -10°C	1 Year/1 Year	
Oil Range Organics-ORO		Solid	8oz Glass Jar	≤ 6°C	14/40 Days	
Oil Range Organics-ORO		Water	1L Amber Glass	≤ 6°C; $Na_2S_2O_3$ if Cl present	7/40 Days	Yes
Oxygen, Dissolved	SM4500-O	Water	Glass	None	15 minutes	

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
(Probe)						
Paint Filter Liquid Test	9095	Water	Plastic/Glass	None	N/A	Yes
Particulates	PM-10	Air	Filters	None	180 Days	Yes
Permanent Gases	EPA 3C	Air	Summa Canister	None	14 Days	
Permanent Gases	EPA 3C	Air	Tedlar Bag or equivalent	None	48 Hours	
pH	SM4500H+B/ 9040	Water	Plastic/Glass	None	15 minutes	Yes
pH	9045	Solid	Plastic/Glass	None	Contact local lab	Yes
Phenol, Total	420.1/420.4/ 9065/9066	Water	Glass	pH<2 H_2SO_4; $\leq 6^\circ$C	28 Days	Yes
Phosphorus, Orthophosphate	SM4500P/ 365.1/365.3	Water	Plastic	Filter; $\leq 6^\circ$C	Filter within 15 minutes, Analyze within 48 Hours	Yes
Phosphorus, Total	SM4500P/ 365.1/365.3/ 365.4	Water	Plastic/Glass	pH<2 H_2SO_4; $\leq 6^\circ$C	28 Days	Yes
Phosphorus, Total	365.4	Solid	Plastic/Glass	$\leq 6^\circ$C	28 Days	Yes
Polynuclear Aromatic Hydrocarbons (PAH)	TO-13	Air	PUF	None	7/40 Days	
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Solid	8oz Glass Jar	$\leq 6^\circ$C	14/40 Days	
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Water	1L Amber Glass	$\leq 6^\circ$C; $Na_2S_2O_3$ if Cl present	7/40 Days	Yes
Polynuclear Aromatic Hydrocarbons (PAH)	8270 SIM	Tissue	Plastic/Glass	$\leq -10^\circ$C	1 Year if frozen/ 40 Days	
Radioactive Strontium	905.0	Water	Plastic/Glass	pH<2 HNO_3	180 days	
Radium-226	903.0/903.1	Water	Plastic/Glass	pH<2 HNO_3	180 days	
Radium-228 (see note 3)	9320/904.0	Water	Plastic/Glass	pH<2 HNO_3	180 days	
Radium-228 (see note 3)	9320	Solid				
Residual Range Organics- Alaska RRO	AK103	Solid	8oz Glass	$\leq 6^\circ$C	14/40 Days	
Saturated Hydrocarbons	SOP S-MN-O-567	Water	$\leq 6^\circ$C; pH<2 1:1 HCl (optional)	14/40 Days preserved; 7/40 Days unpreserved	$\leq 6^\circ$C; pH<2 1:1 HCl (optional)	Yes

Parameter	Method	Matrix	Container	Preservative	Max Hold Time	Additional Volume for MS/MSD
Saturated Hydrocarbons	SOP S-MN-O-567	Solid	≤ 10°C	1 Year/40 Days	≤ 10°C	
Silica, Dissolved	SM4500Si-D	Water	Plastic	≤ 6°C	28 Days	
Solids, Settleable	SM2540F	Water	Glass	≤ 6°C	48 Hours	Yes
Solids, Total	SM2540B	Water	Plastic/Glass	≤ 6°C	7 Days	Yes
Solids, Total	SM2540G	Solid	Plastic/Glass	≤ 6°C	7 Days	
Solids, Total (FOC, OM, Ash)	ASTM D2974	Solid	Plastic/Glass	≤ 6°C	7 Days	
Solids, Total Dissolved	SM2540C	Water	Plastic/Glass	≤ 6°C	7 Days	Yes
Solids, Total Suspended	SM2540D/USGS I-3765-85	Water	Plastic/Glass	≤ 6°C	7 Days	Yes
Solids, Total Volatile	160.4/SM2540E	Water	Plastic/Glass	≤ 6°C	7 Days	Yes
Solids, Total Volatile	160.4	Solid	Plastic/Glass	≤ 6°C	7 Days	Yes
Specific Conductance	SM2510B/9050/120.1	Water	Plastic/Glass	≤ 6°C	28 Days	Yes
Stationary Source Dioxins and Furans	EPA 23	Air	XAD Trap	None	30/45 Days	
Stationary Source Mercury	EPA 101	Air	Filters	None	180 Days, 28 Days for Hg	
Stationary Source Metals	EPA 29	Air	Filters	None	180 Days, 28 Days for Hg	
Stationary Source PM10	EPA 201A	Air	Filters	None	180 Days	
Stationary Source Particulates	EPA 5	Air	Filter/Solutions	None	180 Days	
Sulfate	SM4500SO4/9036/9038/375.2/ASTM D516	Water	Plastic/Glass	≤ 6°C	28 Days	Yes
Sulfide, Reactive	SW-846 Chap.7	Water	Plastic/Glass	None	28 Days	
Sulfide, Reactive	SW-846 Chap.7	Solid	Plastic/Glass	None	28 Days	
Sulfide, Total	SM4500S/9030	Water	Plastic/Glass	pH>9 NaOH; ZnOAc; ≤ 6°C	7 Days	
Sulfite	SM4500SO3	Water	Plastic/Glass	None	15 minutes	
Surfactants (MBAS)	SM5540C	Water	Plastic/Glass	≤ 6°C	48 Hours	Yes
Total Organic Carbon (TOC)	SM5310B,C,D/9060	Water	Glass	pH<2 H_2SO_4 or HCl; ≤ 6°C	28 Days	
Total Organic Carbon (TOC)	9060/Walkley Black	Solid	Glass	≤ 6°C	14 Days	
Total Organic Halogen (TOX)	SM5320/9020/9021	Water	Glass; no headspace	≤ 6°C	14 Days	Yes
Tritium	906.0	Water	Glass	None	180 days	
Turbidity	SM2130B/180.1	Water	Plastic/Glass	≤ 6°C	48 Hours	Yes
Total Uranium	908.0/ASTM D5174-97	Water	Plastic/Glass	pH<2 HCl	180 days	
Volatile Petroleum	MA-VPH	Water	40mL vials	pH<2 HCl;	14 Days preserved	Yes

Parameter	**Method**	**Matrix**	**Container**	**Preservative**	**Max Hold Time**	**Additional Volume for MS/MSD**
Hydrocarbons (aliphatic and aromatic)				≤ 6°C		
Volatile Petroleum Hydrocarbons (aliphatic and aromatic)	MA-VPH	Solid	4-8oz Glass Jar	≤ 6°C; packed jars with no headspace	7/28 Days	
Volatiles	TO-14	Air	Summa Canister	None	30 Days	
Volatiles	TO-14	Air	Tedlar Bag or equivalent	None	48 Hours	
Volatiles	TO-15	Air	Summa Canister	None	30 Days	
Volatiles	TO-18/8260	Air	Tedlar Bag or equivalent	None	72 Hours	
Volatiles	8260	Solid	5035 vial kit	See note 1	14 days	Yes
Volatiles	8260	Water	40mL vials	pH<2 HCl; ≤ 6°C; $Na_2S_2O_3$ if Cl present	14 Days	Yes
Volatiles	8260	Conc. Waste	5035 vial kit or 40mL vials	≤ 6°C	14 Days	
Volatiles	624	Water	40mL vials	pH<2 HCl; ≤ 6°C; $Na_2S_2O_3$ if Cl present	14 Days (7 Days for aromatics if unpreserved)	Yes
Volatiles (see note 2)	524.2	Water	40mL vials (in duplicate)	pH<2 HCl; ≤ 6°C; Ascorbic acid or $Na_2S_2O_3$ if Cl present[2]	14 Days	Yes
UCMR3 Metals	200.8	Water	Plastic or glass	pH<2 HNO_3	28 Days	
UCMR3 Hexavalent Chromium	218.7	Water	HDPE or propylene	$Na_2CO_3/NaHCO_3/(NH_4)_2SO_4$; pH>8	14 Days	
UCMR3 Chlorate	300.1	Water	Plastic or glass	EDA	28 Days	
UCMR3 Hormones	539	Water	Amber glass	$Na_2S_2O_3$, 2-mercaptopyridine-1-oxide, sodium salt	28 Days	
UCMR3 Perfluorinated Compounds	537	Water	Polypropylene	Trizma	14 Days	
UCMR3 Volatiles	524.3	Water	40 mL amber glass vials	Ascorbic acid. Maleic acid pH~2	14 Days	
UCMR3 1, 4 Dioxane	522	Water	Glass	Na_2SO_3, $NaHSO_4$; pH<4	28 Days	
UV254	SM5910B	Water	Glass	≤ 6°C	48 Hours	

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[1] **5035/5035A Note**: 5035 vial kit typically contains 2 vials water, preserved by freezing **or**, 2 vials aqueous sodium bisulfate preserved at 4°C, **and** one vial methanol preserved at ≤6°C **and** one container of unpreserved sample stored at ≤6°C.

[2] Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected, unless gases or Table 7 compounds are NOT compounds of interest and then sodium thiosulfate is the preservative recommended.

[3] Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the lab within 5 days of collection, preserved in the lab, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.

[4] The holding time for hexavalent chromium may be extended by the addition of the ammonium buffer listed in EPA 218.6 per the 2012 EPA Method Update Rule.Although Method 218.6 stipulates a different pH range (9.0 to 9.5) for buffering, this method requirement was modified in the Method Update Rule to a pH range of 9.3 to 9.7.For non-potable waters, adjust the pH of the sample to 9.3 to 9.7 during collection with the method required ammonium sulfate bufferto extend the holding time to 28 days. For potable waters, addition of the buffer during collection will extend the holding time for 14 days per EPA 218.7 and the EPA UCMR3 program.

Appendix E

DEQ Letter Correspondence

- Approved March 2013 Request for Change in Sampling and Analytical Constituents
- Request For Reduction In Groundwater Sampling Analytes, April 2015
- Groundwater Monitoring Statistics

"Healthy environment, healthy people"

Montana Department of
ENVIRONMENTAL QUALITY

Steve Bullock, Governor
Tracy Stone-Manning, Director

P. O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • Website: www.deq.mt.gov

May 2, 2013

Mr. Rick Larson
Butte-Silver Bow Landfill
126 West Granite Street
Butte, MT 59701-9216

RE: **CLOSED BUTTE-SILVER BOW COUNTY LANDFILL – LICENSE #20**
APPROVED – MARCH 2013 REQUEST FOR CHANGE IN SAMPLING AND ANALYTICAL CONSTITUENTS

Dear Mr. Larson:

Thank you for submitting the March 2013 request to discontinue sampling for selected constituents at the closed Butte-Silver Bow County Class II Landfill. The request is approved with the following exceptions:

- Dissolved metals: Please continue to sample for Antimony, Barium, Selenium, and Vanadium during semi-annual sampling. The frequency of sampling for Mercury may be reduced to once every two years.
- Organochlorine herbicides: The frequency of sampling for organochlorine herbicides may be reduced to once every two years.

EPA Method SW8260 may continue to be used for the analysis of 1,2-Dibromo-3-chloropropane and 1,2-Dibromoethane, and the best possible reporting limits for these analyses using method SW8260 will be accepted for solid waste facility samples.

If you have any questions or comments please contact me.

Sincerely,

Martin Van Oort
Environmental Science Specialist
Solid Waste Program
Phone: 406-444-2802, Fax: 406-444-1374
E-mail: mvanoort@mt.gov

cc: Mr. Brad Hollamon, Pioneer Technical Services, PO Box 3445, Butte, MT 59702

File: Closed\Silver Bow Co.\Butte-Silver Bow Class II\License #20\Groundwater Monitoring

DEQ
Montana Department
of Environmental Quality

RECEIVED 4/22/15 BK

April 20, 2015

Mr. David Schultz, P.E.
Butte-Silver Bow Landfill
126 West Granite Street
Butte, MT 59701-9216

RE: **BUTTE-SILVER BOW COUNTY LANDFILL – LICENSE #20**
REQUEST FOR REDUCTION IN GROUNDWATER SAMPLING ANALYTES

Dear Mr. Schultz:

Your consultant, Pioneer Technical Services, submitted a request for reduction in analytes from the current Sampling and Analysis Plan (SAP). The constituents requested for discontinuation are: organochlorine pesticides, chlorinated herbicides and polychlorinated biphenyls (PCB's). Since these constituents have not been detected in any of the wells in over ten years with the exception of estimated concentrations, the request is approved. I look forward to the submittal of a revised SAP which incorporates these changes.

If you have any questions or comments please contact me.

Sincerely,

John Collins
Hydrogeologist
Solid Waste Program
Phone: 406-444-2802, Fax: 406-444-1374
E-mail: jcollins3@mt.gov

Cc: J.D. Emmert, Pioneer Technical Services, PO Box 3445, Butte, MT 59702

File: Closed\Silver Bow Co.\Butte-Silver Bow Class II\License #20\Methane Monitoring
Silver Bow Co.\Butte-Silver Bow Class II\License #330\Methane Monitoring

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Montana Department of
ENVIRONMENTAL QUALITY

Marc Racicot, Governor

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April 17, 2000

RECEIVED
APR 19 2000

James E. Johnston
Public Works Director
Butte-Silver Bow Public Works
Courthouse
Butte, Montana 59701

RE: GROUND WATER MONITORING – STATISTICS

Dear Mr. Johnston:

Enclosed is a copy of the technical paper by Robert D. Gibbons detailing the statistical methodology to which I had referred in my letter dated February 7, 2000. I hope you and/or at least one of your technical representatives were able to attend the Solid Waste Management Facility Monitoring Requirements seminar in Missoula on March 27 and 28, 2000. This prediction interval approach to statistics was presented at the seminar by Tim Stepp with the DEQ. A copy of his slide presentation is enclosed. Should there still be some uncertainty as to how to apply this type of statistical comparison, here is a hypothetical example.

Sample dates	F/96	S/97	F/97	S/98	F/98	S/99	F/2000	S/2000	F/2000
Constituent #1 concentrations	10	10	5	8	9	8	10	9	12

Six to eight data points needed for historical baseline.

In this example, the fall 2000 sample of 12 is above the concentrations in the baseline data. At this point, the facility has two options: 1) begin assessment monitoring, or 2) re-sample. If the concentration in the re-sample is:

- less than or equal to 10, the facility can continue in detection monitoring; or
- greater than 10, the facility must begin assessment monitoring.

One factor under consideration at this time is how broadly this methodology will apply to the Table I (ARM 17.50.708) list of detection monitoring parameters. Most assuredly, it will be applicable to metals analytical data (including arsenic and cyanide). Initial detection of VOCs prompts a re-sample and/or assessment monitoring. This methodology may be most valuable as a quick-look for facilities themselves in evaluating changes/increases in indicator parameters such as specific conductivity, chloride, sulfate, possibly pH, and potentially, for nitrates (if not over the MCL).

This is a very straight forward statistical methodology that does not require calculations, a computer program, or a consultant to figure it out. However, should re-sampling become excessive, such as in the case of seasonality, the facility may want to use a different statistical methodology. At the new Butte-Silver Bow Class II Landfill, there appears to be little change in the data values from the historical baseline concentrations. Therefore, the non-parametric prediction interval method appears to be an appropriate, cost-effective statistical evaluation tool for the Class II facility.

I can be contacted at the Permitting and Compliance Division, Community Services Bureau, Waste Management Section, phone (406)444-0538.

Sincerely,

Pat Potts

Pat Potts –Environmental Specialist
Solid Waste Regulatory Program

cc: Shawn Bisch, Pioneer Technical Services. P.O. Box 3445, Butte, MT 59702
Gary Keeler, Butte-Silver Bow
Dan Powers, R.S.

A General Statistical Procedure for Ground-Water Detection Monitoring at Waste Disposal Facilities

by Robert D. Gibbons[a]

Abstract

Nonparametric upper prediction limits for ground-water detection monitoring are developed. The limit is defined as the maximum of a previous background sample of size n (i.e., $X_{(max,n)}$). The probability that at least one out of the next m measurements (i.e., $Y_{(min,m)}$) will be less than $X_{(max,n)}$ at each of k monitoring wells is computed. In the context of ground-water monitoring, m is equal to the initial new measurement in a particular monitoring well plus m − 1 resamplings of that well. In this way, values of n and m can be selected to assure a desired confidence level (e.g., $\gamma \geqslant .95$). A series of typical examples are described, and a set of Tables that give these probabilities for values of n = 4 to 100, k = 1 to 100, and m = 1 to 3 are provided. Generalization to multiple variables (i.e., indicator parameters) is also discussed.

1. Introduction

There has been considerable controversy over the appropriate statistical methodology for evaluating the impact of waste disposal facilities on ground-water quality. Typically, comparisons are made between a set of historical upgradient background measurements and an individual new monitoring measurement, separately in each of a series of downgradient wells. A single comparison that results in statistical significance at the 5% level is taken as evidence that the facility is impacting ground water, regardless of the number of comparisons made. An additional complication is introduced by the fact that several commonly used variables (i.e., indicator parameters) have markedly nonnormal distributions, that are often resistant to simple data transformation. Furthermore, these distributions are often censored, in the sense that a proportion of the observations are measured below an established method detection limit. For volatile organic priority pollutant compounds, which are commonly used indicators of contamination, the proportion of nondetected values is often in excess of 95%, ruling out the application of traditional statistical methods.

Some attempts at a solution to these problems have been proposed by Gibbons (1987a and 1987b), Davis and McNichols (1987), and McNichols and Davis (1988) by providing prediction limits for future measurements at each of k monitoring wells based on a previous sample of n background measurements. Gibbons (1987a) has suggested solutions to the normal, log-normal, and censored log-normal cases, and Gibbons (1987b) developed both prediction and tolerance regions for the Poisson distribution. Davis and McNichols (1987) extended the work for the normal distribution to include the effects of resampling once a significant difference is detected. Statistical procedures for paired-well comparisons and intrawell comparisons also have been considered by Loftis *et al.* (1987), Harris *et al.* (1987), and Montgomery *et al.* (1987). Statistical prediction and tolerance intervals are now recommended for both detection and compliance monitoring of hazardous waste disposal facilities by the new USEPA statistical regulation (USEPA, 1988).

In this paper, a nonparametric approach to constructing prediction limits is described. Specifically, interest is in the probability that at least one of m future measurements in each of k monitoring wells will not exceed the maximum of n previous samples. For example, consider a hypothetical facility with two upgradient wells and five downgradient wells for which quarterly monitoring produces relatively independent ground-water measurements. In terms of the upgradient wells, two years of quarterly monitoring have taken place yielding 16 background measurements. Using calculations to be described and assuming that (1) the distribution of the indicator parameter is continuous, (2) the distribution of water quality is the same in background and monitoring locations, and (3) the measurements are independent, the probability that the five new monitoring values (i.e., one at each of the five downgradient wells) will be less than the maximum of the 16 background measurements is .762. Clearly, this decision rule does not have a reasonable false positive rate (i.e., 1 − .762 = .238). However, assume that in the 23.8% of the cases in which a false positive result is obtained, the owner/operator is permitted to resample the well and if the new measurement is below the maximum of the 16 background values, the facility could return to normal detection monitoring. With a single resampling, we are now interested in the probability that at least one out of two measurements at each of the five monitoring wells will be less than the maximum of the 16 background measurements. This probability is given in Table 2 as .968 or a false positive rate of only 3.2%. This

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[a] Associate Professor of Biostatistics, University of Illinois at Chicago, ISPI, 1601 W. Taylor, Chicago, Illinois 60612-4397.

Received November 1988, revised April 1989, accepted May 1989.

Discussion open until September 1, 1990

Table 1. Probability That a Single Sample Will Be Below the Maximum of n Background Measurements at Each of k Monitoring Wells

Previous	Number of Monitoring Wells (k)														
n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	.800	.667	.571	.500	.444	.400	.364	.333	.308	.286	.267	.250	.235	.222	.211
5	.833	.714	.625	.556	.500	.455	.417	.385	.357	.333	.312	.294	.278	.263	.250
6	.857	.750	.667	.600	.545	.500	.462	.429	.400	.375	.353	.333	.316	.300	.286
7	.875	.778	.700	.636	.583	.538	.500	.467	.437	.412	.389	.368	.350	.333	.318
8	.889	.800	.727	.667	.615	.571	.533	.500	.471	.444	.421	.400	.381	.364	.348
9	.900	.818	.750	.692	.643	.600	.562	.529	.500	.474	.450	.429	.409	.391	.375
10	.909	.833	.769	.714	.667	.625	.588	.556	.526	.500	.476	.455	.435	.417	.400
11	.917	.846	.786	.733	.687	.647	.611	.579	.550	.524	.500	.478	.458	.440	.423
12	.923	.857	.800	.750	.706	.667	.632	.600	.571	.545	.522	.500	.480	.462	.444
13	.929	.867	.812	.765	.722	.684	.650	.619	.591	.565	.542	.520	.500	.481	.464
14	.933	.875	.824	.778	.737	.700	.667	.636	.609	.583	.560	.538	.519	.500	.483
15	.937	.882	.833	.789	.750	.714	.682	.652	.625	.600	.577	.556	.536	.517	.500
16	.941	.889	.842	.800	.762	.727	.696	.667	.640	.615	.593	.571	.552	.533	.516
17	.944	.895	.850	.810	.773	.739	.708	.680	.654	.630	.607	.586	.567	.548	.531
18	.947	.900	.857	.818	.783	.750	.720	.692	.667	.643	.621	.600	.581	.562	.545
19	.950	.905	.864	.826	.792	.760	.731	.704	.679	.655	.633	.613	.594	.576	.559
20	.952	.909	.870	.833	.800	.769	.741	.714	.690	.667	.645	.625	.606	.588	.571
25	.962	.926	.893	.862	.833	.806	.781	.758	.735	.714	.694	.676	.658	.641	.625
30	.968	.937	.909	.882	.857	.833	.811	.789	.769	.750	.732	.714	.698	.682	.667
35	.972	.946	.921	.897	.875	.854	.833	.814	.795	.778	.761	.745	.729	.714	.700
40	.976	.952	.930	.909	.889	.870	.851	.833	.816	.800	.784	.769	.755	.741	.727
45	.978	.957	.937	.918	.900	.882	.865	.849	.833	.818	.804	.789	.776	.763	.750
50	.980	.962	.943	.926	.909	.893	.877	.862	.847	.833	.820	.806	.794	.781	.769
60	.984	.968	.952	.937	.923	.909	.896	.882	.870	.857	.845	.833	.822	.811	.800
70	.986	.972	.959	.946	.933	.921	.909	.897	.886	.875	.864	.854	.843	.833	.824
80	.988	.976	.964	.952	.941	.930	.920	.909	.899	.889	.879	.870	.860	.851	.842
90	.989	.978	.968	.957	.947	.937	.928	.918	.909	.900	.891	.882	.874	.865	.857
100	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870

Previous	Number of Monitoring Wells (k)														
n	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
4	.167	.138	.118	.103	.091	.082	.074	.068	.062	.058	.054	.051	.048	.043	.038
5	.200	.167	.143	.125	.111	.100	.091	.083	.077	.071	.067	.062	.059	.053	.048
6	.231	.194	.167	.146	.130	.118	.107	.098	.091	.085	.079	.074	.070	.062	.057
7	.259	.219	.189	.167	.149	.135	.123	.113	.104	.097	.091	.085	.080	.072	.065
8	.286	.242	.211	.186	.167	.151	.138	.127	.118	.110	.103	.096	.091	.082	.074
9	.310	.265	.231	.205	.184	.167	.153	.141	.130	.122	.114	.107	.101	.091	.083
10	.333	.286	.250	.222	.200	.182	.167	.154	.143	.133	.125	.118	.111	.100	.091
11	.355	.306	.268	.239	.216	.196	.180	.167	.155	.145	.136	.128	.121	.109	.099
12	.375	.324	.286	.255	.231	.211	.194	.179	.167	.156	.146	.138	.130	.118	.107
13	.394	.342	.302	.271	.245	.224	.206	.191	.178	.167	.157	.148	.140	.126	.115
14	.412	.359	.318	.286	.259	.237	.219	.203	.189	.177	.167	.157	.149	.135	.123
15	.429	.375	.333	.300	.273	.250	.231	.214	.200	.187	.176	.167	.158	.143	.130
16	.444	.390	.348	.314	.286	.262	.242	.225	.211	.198	.186	.176	.167	.151	.138
17	.459	.405	.362	.327	.298	.274	.254	.236	.221	.207	.195	.185	.175	.159	.145
18	.474	.419	.375	.340	.310	.286	.265	.247	.231	.217	.205	.194	.184	.167	.153
19	.487	.432	.388	.352	.322	.297	.275	.257	.241	.226	.213	.202	.192	.174	.160
20	.500	.444	.400	.364	.333	.308	.286	.267	.250	.235	.222	.211	.200	.182	.167
25	.556	.500	.455	.417	.385	.357	.333	.312	.294	.278	.263	.250	.238	.217	.200
30	.600	.545	.500	.462	.429	.400	.375	.353	.333	.316	.300	.286	.273	.250	.231
35	.636	.583	.538	.500	.467	.437	.412	.389	.368	.350	.333	.318	.304	.280	.259
40	.667	.615	.571	.533	.500	.471	.444	.421	.400	.381	.364	.348	.333	.308	.286
45	.692	.643	.600	.562	.529	.500	.474	.450	.429	.409	.391	.375	.360	.333	.310
50	.714	.667	.625	.588	.556	.526	.500	.476	.455	.435	.417	.400	.385	.357	.333
60	.750	.706	.667	.632	.600	.571	.545	.522	.500	.480	.462	.444	.429	.400	.375
70	.778	.737	.700	.667	.636	.609	.583	.560	.538	.519	.500	.483	.467	.437	.412
80	.800	.762	.727	.696	.667	.640	.615	.593	.571	.552	.533	.516	.500	.471	.444
90	.818	.783	.750	.720	.692	.667	.643	.621	.600	.581	.562	.545	.529	.500	.474
100	.833	.800	.769	.741	.714	.690	.667	.645	.625	.606	.588	.571	.556	.526	.500

2^{20} = 1,048,576 terms. With two resamples we have 3^{20} = 3,486,784,401 terms. In light of this, the required probabilities are computationally restricted to cases in which the required number of resamplings and number of monitoring wells are reasonably small. Fortunately, an excellent approximation using the Bonferonni inequality (Miller, 1985) can be derived easily. In this context, the Bonferonni inequality implies that if we construct a limit assuming $k = 1$, but actually apply it to $k = t$ monitoring wells, where $t > 1$, then the simultaneous probability that all t measurements will be included in the limit is approximately γ^t. In light of this, we can easily evaluate equation (2) for $k = 1$, but report $\gamma = \gamma^t$. The approximated probability is therefore:

$$\gamma \cong \left[\frac{n}{m+n} \sum_{j=1}^{m} \frac{\binom{m}{j}}{\binom{m+n-1}{j+n-1}} \right]^k \tag{3}$$

Returning to our example of $n = 16$, $k = 5$, and $m = 2$, we find:

$$\gamma \cong \left[\frac{16}{2+16} \left(\frac{\binom{2}{1}}{\binom{2+16-1}{1+16-1}} + \frac{\binom{2}{2}}{\binom{2+16-1}{2+16-1}} \right) \right]^5$$

$$\gamma \cong \left[.8889 \left(\frac{2}{17} + 1 \right) \right]^5 = .968$$

Table 3. Probability That At Least One Out of Three Samples Will Be Below the Maximum of n Background Measurements At Each of k Monitoring Wells

Previous	Number of Monitoring Wells (k)														
n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	.971	.944	.917	.891	.866	.840	.816	.793	.770	.748	.727	.706	.686	.666	.647
5	.982	.962	.947	.930	.914	.896	.882	.866	.850	.835	.820	.806	.791	.777	.763
6	.988	.976	.965	.953	.942	.931	.920	.909	.898	.887	.877	.866	.856	.846	.836
7	.992	.983	.975	.967	.959	.951	.942	.935	.927	.920	.912	.904	.897	.889	.882
8	.994	.988	.982	.976	.970	.964	.958	.953	.947	.941	.934	.930	.924	.918	.913
9	.995	.991	.986	.982	.977	.973	.966	.964	.960	.955	.951	.947	.942	.938	.934
10	.997	.993	.990	.986	.983	.979	.976	.972	.969	.966	.962	.959	.955	.952	.949
11	.997	.995	.992	.989	.986	.984	.981	.978	.976	.973	.970	.968	.965	.962	.960
12	.998	.996	.993	.991	.989	.987	.985	.983	.980	.978	.976	.974	.972	.970	.968
13	.998	.996	.995	.993	.991	.989	.988	.986	.984	.982	.981	.979	.977	.976	.974
14	.999	.997	.996	.994	.993	.991	.990	.988	.987	.985	.984	.982	.981	.980	.978
15	.999	.998	.996	.996	.994	.993	.991	.990	.989	.988	.987	.985	.984	.983	.982
16	.999	.998	.997	.996	.995	.994	.992	.992	.991	.990	.989	.988	.987	.986	.985
17	.999	.998	.997	.996	.996	.995	.994	.993	.992	.991	.990	.990	.989	.988	.987
18	.999	.999	.998	.997	.996	.995	.995	.994	.993	.993	.992	.991	.990	.990	.988
19	.999	.999	.998	.997	.997	.996	.995	.995	.994	.994	.993	.992	.992	.991	.990
20	.999	.999	.998	.998	.997	.997	.996	.995	.995	.994	.994	.993	.993	.992	.992
25	1.00	.999	.999	.999	.998	.998	.998	.998	.997	.997	.997	.996	.996	.996	.995
30	1.00	1.00	.999	.999	.999	.999	.998	.998	.998	.998	.998	.998	.998	.997	.997
35	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.998	.998	.998
40	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999
45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999
60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Previous	Number of Monitoring Wells (k)														
n	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
4	.560	.484	.419	.362	.314	.271	.235	.203	.178	.153	.131	.114	.098	.074	.056
5	.697	.637	.582	.532	.486	.444	.406	.371	.339	.310	.282	.259	.237	.198	.165
6	.787	.741	.698	.658	.619	.583	.549	.518	.487	.459	.432	.407	.384	.340	.302
7	.840	.811	.778	.745	.716	.686	.658	.631	.605	.580	.557	.534	.512	.471	.433
8	.886	.859	.833	.808	.784	.761	.738	.716	.694	.674	.653	.634	.616	.579	.544
9	.913	.892	.872	.853	.833	.815	.796	.778	.761	.744	.727	.711	.695	.664	.634
10	.932	.916	.900	.885	.869	.854	.839	.826	.810	.796	.783	.769	.756	.730	.705
11	.946	.934	.921	.908	.896	.884	.871	.860	.848	.836	.825	.814	.803	.781	.759
12	.957	.946	.935	.926	.916	.906	.896	.886	.876	.867	.857	.848	.839	.820	.802
13	.965	.958	.948	.939	.931	.923	.915	.906	.898	.890	.882	.874	.867	.851	.836
14	.971	.964	.957	.950	.943	.936	.929	.922	.916	.909	.902	.896	.889	.876	.863
15	.976	.970	.964	.958	.952	.946	.941	.935	.929	.923	.918	.912	.907	.896	.885
16	.980	.975	.969	.965	.960	.955	.950	.945	.940	.935	.930	.925	.921	.911	.902
17	.983	.978	.974	.970	.966	.961	.957	.953	.949	.945	.940	.936	.932	.924	.916
18	.986	.981	.978	.974	.970	.967	.963	.959	.956	.952	.949	.945	.942	.935	.928
19	.987	.984	.981	.978	.974	.971	.968	.965	.962	.959	.956	.952	.949	.943	.937
20	.989	.986	.983	.980	.978	.975	.973	.969	.967	.964	.961	.959	.956	.950	.945
25	.994	.992	.991	.989	.988	.986	.985	.983	.982	.980	.979	.977	.976	.973	.970
30	.996	.995	.995	.994	.993	.992	.991	.990	.989	.988	.987	.986	.985	.984	.982
35	.998	.997	.996	.996	.995	.995	.994	.994	.993	.993	.992	.991	.991	.989	.988
40	.998	.998	.998	.997	.997	.996	.996	.996	.995	.995	.994	.994	.994	.993	.992
45	.999	.999	.998	.998	.998	.997	.997	.997	.997	.996	.996	.996	.995	.995	.994
50	.999	.999	.999	.999	.998	.998	.998	.998	.997	.997	.997	.997	.997	.996	.996
60	1.00	.999	.999	.999	.999	.999	.999	.999	.998	.998	.998	.998	.998	.998	.997
70	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.998
80	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999
90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999
100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999

various combinations of numbers of background samples and numbers of monitoring wells on the integrity of detection monitoring decisions. In practice, it is hard to imagine having more than a single resample (i.e., m = 2, see Table 2).

Use of these Tables is now illustrated with a series of examples.

3. Examples

Case 1

A facility obtained seven background measurements prior to operation and wants to identify the optimum detection monitoring plan for its 15 monitoring wells at a 95% confidence level. Since n is fixed at 7 and k is fixed at 15, we must identify an optimum number of resamplings such that γ ≥ .95. Inspection of Table 2 for k = 15 and

Table 4. Comparison of Exact and Approximate Solutions

	1 Resample				2 Resamples		3 Resamples	
	K=5		K=10		K=5		K=5	
N	exact	approx	exact	approx	exact	approx	exact	approx
5	.923	.754	.726	.614	.928	.914	.987	.961
10	.933	.927	.882	.872	.984	.980	.995	.995
20	.979	.979	.961	.955	.997	.997	1.00	1.00
50	.995	.996	.993	.992	1.00	1.00	1.00	1.00
100	.999	.999	.998	.998	1.00	1.00	1.00	1.00

small numbers of background observations, that is to be applied to a large number of monitoring wells. As illustrated in the following example, a far more judicious choice is to use the method presented here to determine the number of background measurements that are required to insure 95% confidence that the maximum background measurement exceeds at least one of two new monitoring measurements (i.e., a single resample) at each of k monitoring wells. In practice, a single resample is commonly used as a method of verifying an anomalous result. If resampling a well that fails a traditional statistical test is permitted, we are in effect requiring that the limit exceed only one of two potential measurements.

Case 2

A facility with 20 monitoring wells is only permitted a single resampling by state law. How many background measurements must be obtained such that the maximum will have 95% probability of exceeding at least one of the two measurements at each of the 20 monitoring wells? The answer to this question can be found by inspecting Table 2 under the column $k = 20$. A background sample size of $n = 25$ yields $\gamma = .945$, and $n = 30$ yields $\gamma = .960$. Linear interpolation yields $n = 27$ ($\gamma = .951$). Alternatively, inspection of Table 5 reveals that for $k = 20$, $n = 30$ is the smallest number of background measurements that achieves 95% confidence with a single resampling.

Case 3

A new landfill has one year to obtain four quarterly measurements in a single well before operation. State law requires a single resampling. How many monitoring wells should the owner/operator install in order to obtain 95% confidence that at least one of the two measurements at each monitoring well will not exceed the largest of the four background measurements? Inspection of Table 2 reveals that it is hopeless; even with a single monitoring well, we can at most have .933 confidence. Inspection of Table 5 reveals that even with as few as three monitoring wells, three resamplings would be required to acheive a 95% confidence level. Furthermore, from a hydrogeological perspective, characterizing background water quality with a single background well is not a very reasonable choice. From a statistical perspective, a single background well produces a confound between contamination and spatial variability that cannot be resolved without additional background wells. Finally, the selection of monitoring wells should be based on a detailed hydrogeological understanding of the site and not simply statistical optimization. Conversely, placing large numbers of monitoring wells on a site may be of some hydrogeological interest, but it will make it almost impossible to develop a statistically rigorous detection monitoring program.

Case 4

Consider a facility with five upgradient wells monitored quarterly for one year ($n = 20$), and 12 downgradient monitoring wells ($k = 12$). In the event of a statistical failure, the owner/operator is permitted to resample the well in question, and if the resample does not exceed the statistical limit, he may continue with normal detection monitoring in the following quarter. Benzene is of particular interest at this facility due to high levels of benzene in the leachate. Of the 20 background measurements, there were 17 nondetects and three detected values of 10, 12, and 16 ppb, respectively. The upper prediction limit for benzene is, therefore, 16 ppb. Inspection of Table 2 reveals that with $n = 20$, $k = 12$, and $m = 2$, we can have 94.9% confidence that either the initial measurement or the resample will not exceed 16 ppb in each of the 12 downgradient monitoring wells. For example, if 11 of the 12 downgradient wells yielded nondetects for benzene and one well yielded a value of 20 ppb, then we would only resample that single well. If the resample exceeded 16 ppb, a statistical failure would be recorded; otherwise, the owner/operator would continue with normal detection monitoring on the next quarterly sampling event. It is important to realize that we do not have to resample the 11 wells that did not exceed the limit on the first sample. The prediction limit is for *at least* one of two samples; therefore, the requirement is met if the first sample does not exceed the limit.

4. Discussion

Nonparametric prediction limits provide a straightforward approach to detection monitoring for a wide variety of potential indicator parameters at waste disposal facilities. With the use of resampling as a fundamental part of the probability statement, remarkably small background sample sizes are required to provide simultaneous 95% upper predictor limits for relatively large numbers of monitoring wells. Without taking resampling into consideration, however, nonparametric prediction limits require background sample sizes that are generally too large to be of practical value. This point also has been raised in the new statistical rule (USEPA, 1988).

An important feature of the resampling is that the repeated samples must be independent. This rules out possible strategies in which a single sample is split into aliquots and simply reanalyzed. Similarly, in areas in which ground water moves slowly, it may be difficult to get repeat samples in a reasonable time-frame to both insure independence and protect the environment. The potential effect of correlated measurements on this method is clear. Since we only resample elevated initial measurements, if the resample and the initial sample are correlated, we would expect the resample to have an increased probability of also being elevated and have an increased likelihood of exceeding the limit. The result, of course, is an increased false positive rate and a decision rule that is more protective of the environment than of industry. In practice, however, resamples are generally not taken within days of the initial sample. With the amount of time required for transport, analytical work, and sampling, the resample is typically obtained within a few weeks or even a month of the initial sample, and as such, serial dependence may be less of a problem.

In the examples considered here, we have only dealt

Appendix F

Field Parameter Form

FIELD SAMPLE DATA SHEET

Page __ of __

Project Name: Old Landfill/Clark Tailings Groundwater Monitoring

WELL/STATION ______ ________________ DATE ________________ TIME ______________

SAMPLERS ________________ WEATHER CONDITIONS ______________________

PHOTO: Yes ______ No _____ ROLL# ______ NUMBER ________

PURGE DATA:

WELL DEPTH ________ Feet

DEPTH TO WATER ________ Feet

COLUMN DEPTH ________ Feet

CASING DIAMETER ________ Inch

PUMP SET AT ________ Feet

3 WELL VOLUMES ________ Gallons

TOTAL PURGE VOLUME ________ Gallons

PURGE METHOD __________________________

START PURGING _________________

PURGE RATE ________ GPM

RATE CHANGE 1) Time ______ Rate ________

2) Time ______ Rate ________

SAMPLE TIME _________________

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
	250 ml		HNO_3	Dissolved Metals-
	1 Liter			
	250 ml			
	250 ml			
	40 ml			

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: ____

Pioneer Technical Services

File: Silver Bow Co
"old" Butte Ldfll
grdwtr

WORK PLAN
FOR
HYDROGEOLOGIC AND SOILS STUDY

Butte-Silver Bow County Landfill

Special Resource Management INC.

RECEIVED

OCT 0 9 1992

MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

WORK PLAN
FOR
HYDROGEOLOGIC AND SOILS STUDY

Butte-Silver Bow County Landfill

Prepared For:
Butte-Silver Bow

Prepared by:

Special Resource Management, Inc.
PO Box 4168
Butte, MT 59702

October 6, 1992
SRM Project No.:31-00976-002

Special Resource Management INC.

P.O. Box 4168 • Butte, MT 59702
(406) 782-4201 • (800) 735-8964 • (406) 782-9968 FAX

A Montana Power/Entech Company • AA/EOE M/F

RECEIVED

OCT 0 9 1992

MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

Pat Potts, Environmental Specialist
Montana Department of Health & Environmental Sciences
Solid & Hazardous Waste Bureau
Cogswell Building
Helena, MT 59620

October 8, 1992

Re: Transmittal of Workplan for Hydrogeologic and Soils Study
Butte-Silver Bow Landfill
SRM 31.00976.002

Dear Ms Potts:

Enclosed are 2 copies of the Workplan, for the Hydrogeologic and Soils Study on the existing Butte-Silver Bow Landfill, as requested in your 7/7/92 letter to Butte-Silver Bow. We are transmitting this directly to you at the direction of James Johnston, Director or Public Works for Butte-Silver Bow.

If you have any questions or comments on this plan, please contact Doug Anderson here at SRM.

Sincerely,

Edward L Handl

Edward L. Handl, P.E.
Manager, Technical Services

Copy: Jim Johnston/Mike Shea - Butte-Silver Bow

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1.0 Introduction

The purpose of this work plan is to describe, in detail, the investigatory work comprising the Hydrogeologic and Soils Study at the existing Butte-Silver Bow Landfill. The existing landfill is located in Township 3 north, Range 8 west, Southeast ¼ of Section 25. All investigatory work will be completed according to Administrative Rules of Montana (ARM), Title 16, Chapter 14, Subchapter 7, Groundwater Monitoring Regulations. All well drilling, borings and backhoe pits, and well development will be documented on the Montana Department of Health and Environmental Sciences' Forms (Monitoring Well Construction Form, Soil Boring Form, and Well Development Form).

2.0 Site Conditions

The Butte-Silver Bow landfill is located in alluvial valley fill which lies on top of the Cretaceous boulder batholith. The fill is expected to be fairly thin and it is the water table aquifer in the area. Depth to water ranges between 5 and 15 feet in the landfill area. Due to the shallow water table and the surface area which has been affected by landfill activities, an impact on groundwater quality is expected. Additionally, the effect of mine/mill tailings located to the adjacent to the landfill to the east, is unknown.

Therefore, this workplan describes well locations which will identify impacts that may have occurred due to the operation of the Butte-Silver Bow municipal landfill. The proposed monitoring well locations are not meant to completely identify all possible onsite and offsite routes of contamination, or the extent of contamination, but rather to identify a starting point for the investigation. Once these wells have been installed and monitored, the data will be used to propose well locations for the next phase of the investigation.

3.0 Site Investigation

The site investigation will consist of installing seven (7) backhoe pits, six (6) soil borings, twelve (12) shallow monitoring wells, and four (4) deep monitoring wells, locations are shown in Figure 1. The purpose of the deep wells is to identify any dense phase material that may sink to bedrock and migrate along the alluvial/bedrock contact. The site consists of approximately 81 acres of landfill area and, therefore, will require 45 borings and/or backhoe pits according to ARM. Since the area has been filled with refuse and additional borings in the active area will not provide information on the natural geologic conditions at the site, completing the required number of borings will not supply any additional valuable information at this time. Also, since the potential for contamination at this site is very high, additional wells will most likely be required to delineate a ground water contamination plume resulting from the landfill. This investigation will provide the necessary information to fully describe the geologic and

hydrogeologic characteristics at the site, however, additional work will probably be required to determine the extent, degree, and fate of contaminants at the site.

3.1 Record Search

In order to start the investigation, a literature search will be conducted to gather all available information on the hydrology, geology, and hydrogeology of the site. This information will be collected from the United States Geological Survey (USGS), the Montana Bureau of Mines and Geology (MBMG), and other State agencies such as the Department of Natural Resources and Conservation (DNRC) or the Department of Health and Environmental Sciences (DHES).

This information shall identify the regional stratigraphy, structural geology, and depositional history. Site specific characteristics will be identified from data collected during the investigation.

3.2 Hydrologic Characterization

The hydrologic characterization will identify the recharge and discharge areas for the site. Identification will consist of mapping the recharge area, based on surface water divides. The groundwater discharge area will be delineated once ground water flow characteristics have been determined. Based on the above information plus precipitation data, a water budget for the site will be calculated.

3.3 Geologic Characterization

The geologic characterization shall identify all pertinent subsurface units in the landfill area. Boring logs shall be used to construct a geologic model of the site. Each unit encountered in the subsurface will be described and classified according to ASTM designation D2487-85 "Standard Test Method for Classification of Soils for Engineering Purposes" and ASTM Designation D2488-84 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure" by a qualified professional.

Soil samples will be collected from five foot intervals on all borings and wells. Boring logs will be constructed for each boring and backhoe pit constructed at the site. Logs will be completed on the forms supplied by the Montana Department of Health and Environmental Sciences, Solid Waste Program. Samples of the surface soil will be analyzed for the following chemical characteristics: Soil Organic Content (SOC), pH, and Cation Exchange Capacity (CEC). Soil and subsurface materials will be analyzed for the following physical parameters: Grain Size Distribution and Atterberg Limits.

The information gathered during the investigation will be used to construct geologic cross

sections of the site. These cross sections will provide the basis for interpretation of the aquifer extent and interconnection across the site.

3.4 Hydrogeologic Characterization

The hydrogeologic investigation of the site will identify and describe all hydrogeologically significant units at the site. Each unit will be characterized by the following physical parameters: Soil Classification and Grain size. The following Hydraulic parameters will be determined by conducting slug tests and constructing well logs for each monitoring well: Hydraulic Conductivity (K), Transmissivity (T), Storativity (s), Thickness (b), and lateral extent of the aquifer.

Information derived from the proposed soil borings and monitoring wells will identify the groundwater characteristics of the site (flow direction and flow velocity). Based on these data, the need for additional wells will be assessed and proposed, if necessary.

3.5 Data Reporting

3.5.1 Hydrogeologic Report

The hydrogeologic report shall describe the surface water characteristics of the sites including estimated flow volumes, aquifer recharge and discharge, precipitation characteristics, and all documentation and calculations for the site water budget.

The hydrogeologic report will define the structural geology and bedrock conditions of the site. Several cross sections will be generated depicting the extent (to include depth, thickness, and lateral extent) of geological units which may direct and/or restrict leachate migration pathways. Geologic features identified during field investigations will include bedrock characteristics, unconsolidated deposits, fracture zones, and confining layers.

The hydrogeologic report shall include a description of construction design, location(s), elevations, well log(s), and sampling data of all proposed wells, borings, and backhoe pits. Cross sections shall be generated from the boring logs depicting the water bearing zone and subsurface hydrogeology. Based on the field data, tests and cores, a representative and accurate classification and description of the hydrogeologic units shall be presented. Significant aquifers that are identified will be described.

The hydrogeologic report shall include and explain all calculations supporting the groundwater flow directions and velocities, determinations of hydraulic conductivity, transmissivity, porosity, permeability, and estimated leachate transport times. The subsurface hydrologic characterizations

will be based on field slug tests.

3.5.2 Soils Investigation Report

The soil units above the water table will be described and characterized according to ASTM procedures. Atterberg Limits, size distribution, organic content, pH, mineral content, and moisture content data will be provided in the Soils Investigation Report. This report will also contain a soil distribution map and soil profiles for the site.

3.6 Decontamination Process

To ensure reliable sample quality, all drilling equipment shall be decontaminated with an appropriate cleaning technique before mobilization and between borings. When soil samples are collected, the sampling equipment shall be decontaminated prior to collection of each soil sample. Appropriate cleaning techniques shall include steam cleaning and/or a laboratory grade detergent wash and distilled water rinse. All foreign materials on sampling tools (i.e. soil, refuse...) will be removed.

All bailers and sample containers shall be laboratory cleaned or decontaminated by an appropriate cleaning technique.

At no times shall a suspected non-contaminated sampling tool be re-used without first being decontaminated. It is the responsibility of the field personnel to follow accepted procedures when decontaminating and cleaning sampling equipment and tools in the field.

3.7 Sampling Details

SRM has developed a drilling and backhoe pit excavation program to generate the necessary information to characterize hydrogeologic, hydrologic and geological conditions at the referenced project site. The following tables present the sampling quantities that will be collected to characterize the subsurface geological and hydrogeological units, and groundwater quality.

Table 3.7.1 Backhoe Excavation Samples

Sample	**pH**	**SOC**	**CEC**
Backhoe Pit	One sample per Backhoe pit	One Sample per Backhoe Pit	One sample per Backhoe pit

Table 3.7.2 Soil Boring Samples

Sample	Sieve Analysis	Atterberg
Soil Boring	3 Samples per water bearing zone	1 Sample per Soil Type

Table 3.7.3 Monitoring Well Samples

Sample	Appendix A Parameters
Monitoring Well	One Water Sample Per Well(1)

[1] To be collected after Sampling and Analysis Plan has been approved by the Department.

3.8 Health and Safety Considerations

Ground water contamination at the site is expected to consist of elevated concentrations of major anions, cations, metals, and possibly also synthetic compounds in the parts per billion range. Therefore, protective cotton coveralls, rubber gloves, safety glasses, and a hard hat will provide adequate protection. These initial precautions will prevent potentially contaminated ground water from contacting sampling personnel. If ground water at the site is determined to be highly contaminated, a Health and Safety Plan will be completed for the site before additional sampling will be conducted.

Field monitoring data will be used during sampling to determine if purge water from the monitoring wells will need to be containerized. If the initial photoionization reading or the field ground water monitoring parameters (pH, SC, Temp.) indicate a degraded water quality, purge water will be containerized until the analytical results are available from the lab. The laboratory results will be used to determine the disposal options for the purge water. If the water is determined to be nonhazardous, it will be disposed of on the ground at the site.

3.8.1 Methane Monitoring

Since this is an old landfill and methane production is possible, monitoring for combustible gases will be performed in and around the bore hole as follows:

1) At the beginning of each work shift.
2) Following extended periods when the control/exclusion zone has been evacuated.
3) Prior to any spark or flame producing activity that is within ten (10) feet of the bore hole.

4) Monitoring will be conducted within a three (3) foot radius of the borehole.

If combustible gas levels exceed 10% LEL, no flame or spark producing operations may be performed. The bore hole must be allowed to ventilate until the levels drop to background and the source can be identified.

As per manufacturer's requirements, the Combustible Gas Analyzer will be calibrated on a monthly basis. Calibration will consist of comparing instrument read-out in " % LEL ", with a span gas. If the results of the comparison are not within the limits of the manufacturer's specifications, the instrument will be adjusted accordingly.

4.0 Investigation Deliverables

All data collected from the investigation will be summarized into two reports: Hydrogeologic Characterization of the Butte-Silver Bow Landfill and Soil Investigation Report for the Butte-Silver Bow Landfill. These reports will provide the information necessary to satisfy ARM Title 16, Chapter 14, Subchapter 7 Groundwater monitoring regulations.

5.0 Project Schedule

A tentative project schedule for the Butte-Silver Bow Landfill Hydrogeologic and Soil Study is shown in Table 5.1, below. The drilling and backhoe pit excavation activities can commence approximately 20 days after the Department approves the work plan. The field activities should be completed within 160 days of the Department's approval. As required by regulations, within 180 days of Department approval, relevant information and laboratory results shall have been compiled, and the final reports submitted to the state for review. Since start of the field work is contingent on Department approval of the work plan, actual dates for field activities are subject to change.

Table 5.1 Project Schedule (days after Department approval)

Task	**Start**	**Completion**
Borings and Backhoe pits	20	45
Shallow Monitoring Wells	30	60
Deep Monitoring Wells	45	70
Aquifer Tests	70	90
Soil Analysis	30	60
Ground Water Sampling	70	90
Ground Water Analysis	85	120
Report Preparation and Review	100	160
Final Report	160	180

6.0 Conclusions

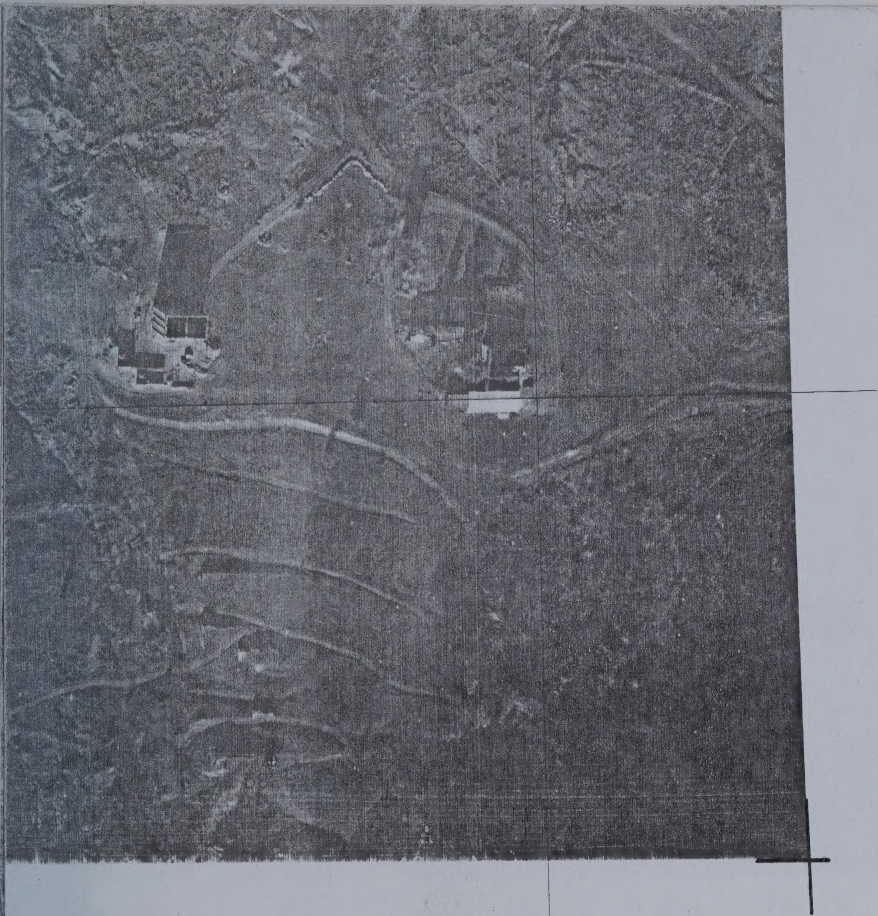
The Butte-Silver Bow County Landfill hydrogeologic and soil study program will generate the necessary information to properly characterize the reference site. The program shall consist of drilling soil borings and excavating backhoe pits at various locations to characterize the subsurface, hydrologic and geologic conditions. Monitoring wells will be completed (as determined by the onsite hydrogeologist) to evaluate and detect the existing or potential contamination at this facility. The hydrogeologic study will provide meaningful data on the distribution and characteristics of the aquifer(s), define the groundwater flow system, evaluate the extent and rate of lateral and vertical migration of contamination from the source, and characterize the degree and nature of contamination.

The soils will be described and classified according to Atterberg's Limits. The results of the study will define the effect of soil stratification on unsaturated and saturated flow.

Appendix A

Groundwater Analytes

Parameter	EPA Method	Detection Limit(mg/l)
Water Quality		
Ammonia	350.1	0.1
Bicarbonate	310.1	1
Calcium	215.1	1
Chloride	325.3	1
Iron	236.1	0.03
Magnesium	242.1	1
Manganese	243.1	0.02
Nitrate	353.2	0.05
Potassium	258.1	1
Sodium	273.1	1
Sulfate	375.3	1
COD	410.1	1
TDS	160.1	1
TOC	415.2	2
TSS	160.2	1
SC	120.1	1 μmhos/cm
pH	150.1	0.01 STD units
Metals		
Arsenic	206.3	0.005
Barium	208.1	0.1
Cadmium	213.1	0.001
Chromium	218.1	0.02
Cyanide	335.3	0.005
Lead	239.2	0.01
Mercury	245.2	0.001
Selenium	270.3	0.005
Silver	272.2	0.005
Volatile Organic Compounds		
VOC	8240	Dependant upon matrix



ORING WELLS
ed above bedrock)

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TE, MT

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ITS

TTE, MT

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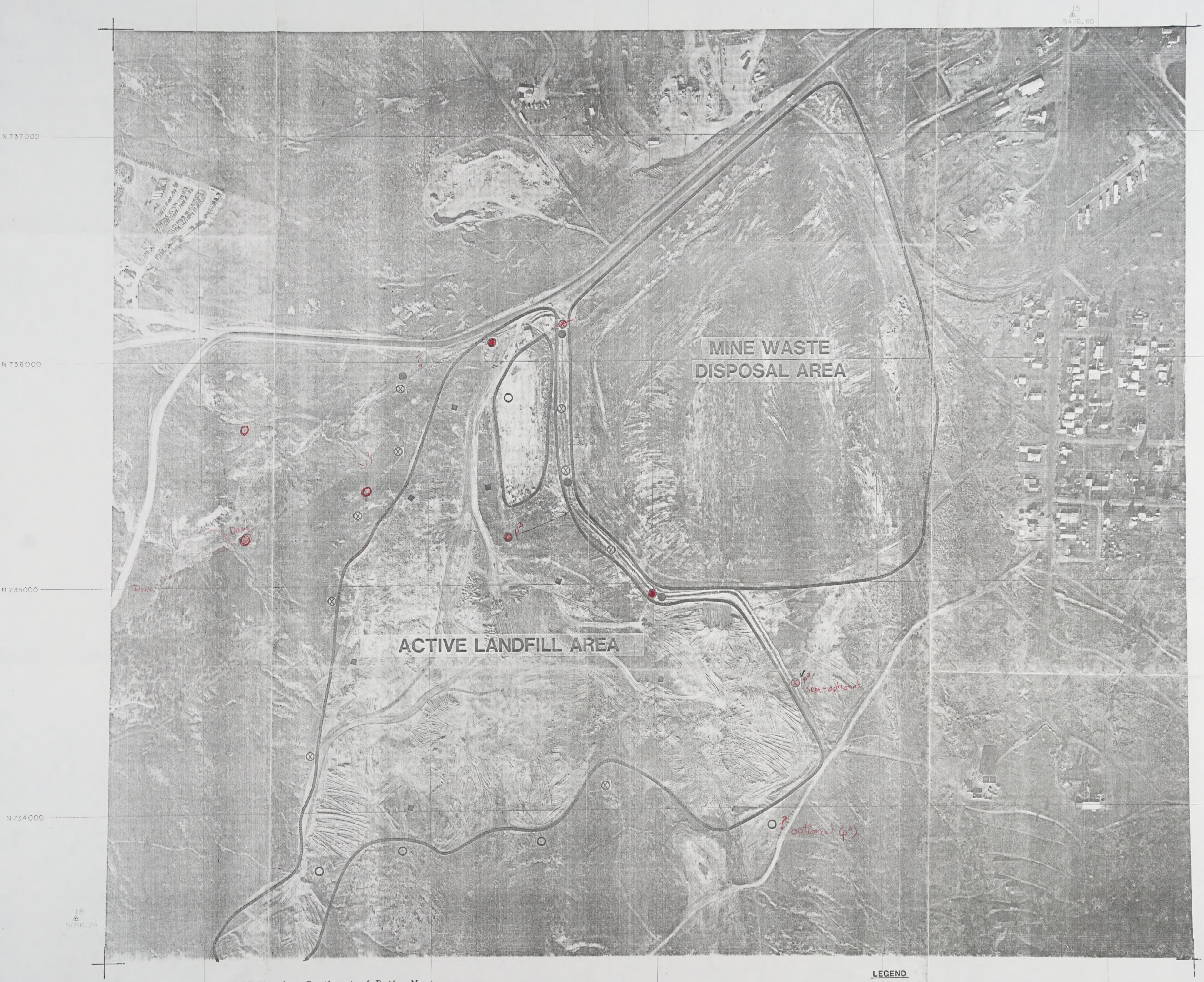
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5476.80
N 737000
N 736000
N 735000
N 734000
MINE WASTE DISPOSAL AREA
ACTIVE LANDFILL AREA
5330.80
18
5656.24
?
Dam
Dam
p^3
✓ p^3
SRM=optional
? optional (p^3)

SITE NO. 2 – Southeast of Butte, Montana
Portions of Sections 25,26,35 & 36, T3N, R8W, P.M.,M.

What about bkgd well?

Prepared for: SPECIAL RESOURCE MANAGEMENT, INC.
P.O. Box 4168 Butte, Montana 59702

Aerial Photography: Montana Aerial Photography
Mapping & Orthophotography: Martinez Corporation
Date of Photography: November 2, 1990

Prepared by: Professional Consultants, Incorporated
P.O. Box 3416 Missoula, Montana 59806
PCI Project: 4337-90

MARTINEZ CORPORATION

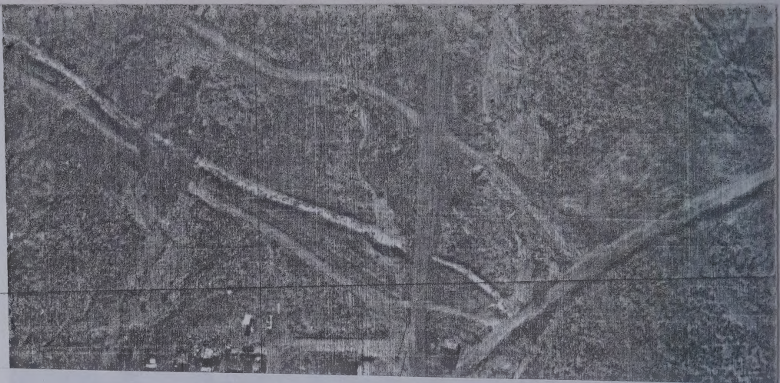
SCALE 1" = 200'
200 0 200 400 600 800
GRAPHIC SCALE IN FEET

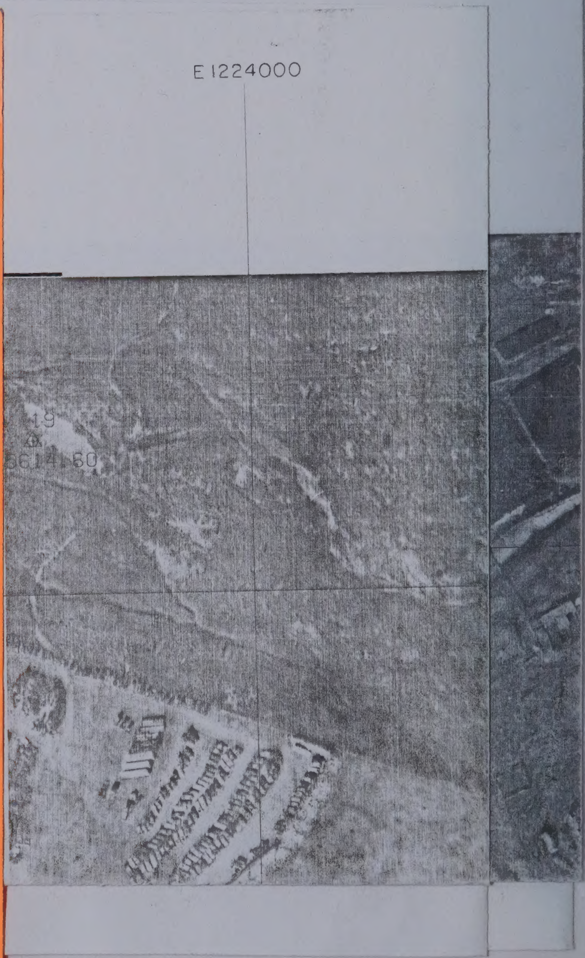
LEGEND

- ● DEEP MONITORING WELLS (screened above bedrock)
- ⊗ MONITORING WELLS
- ○ BORINGS
- ■ BACK HOE FITS

SITE 2 BUTTE, MT

N

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County Silver Bow (closed)
Facility & # Old Butte-Silver Bow #29

Closure
Finan Assur
GW Corr Meas
GW Monitoring
[✓ GW Reports]
Inspections
Other: ____________

Landfarm
Liner
Methane
O & M
Run-on

BUTTE-SILVER BOW
OLD LANDFILL FACILITY GROUNDWATER SAMPLING AND ANALYSIS PLAN (SAP)

Prepared for:

Butte-Silver Bow
Department of Public Works
126 W. Granite
Butte, Montana 59701

Prepared by:

PIONEER
TECHNICAL SERVICES, INC.
P. O. Box 3445
Butte, Montana 59702

March 13, 2009

RECEIVED
MAR 13 2009
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

PIONEER
TECHNICAL SERVICES, INC.

P.O Box 3445, Butte, MT 59702
www.pioneer-technical.com

RT
RECEIVED

MAR 13 2009

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

March 12, 2009

Mr. Martin Van Oort
DEQ/Solid Waste Program
P.O Box 200901
Helena, MT 59620-0901

Dear Martin:

Please find enclosed one copy of the revised Sampling and Analysis Plan for the groundwater sampling conducted at the old Butte-Silver Bow County Landfill. This updated plan is being submitted in response to your letter dated December 16, 2008 to Mr. Gary Keeler (Butte-Silver Bow Landfill Manager). If you have any questions regarding the enclosed Sampling and Analysis Plan, please feel free to contact Brad Hollamon at 782-5177 or me at 563-9371. Thank You.

Sincerely,

Brad Hollamon for

Shawn Bisch
Principal/Senior Engineer

Encl.

cc Gary Keeler, BSB Landfill Manager
Brad Hollamon, Bisch, Pioneer
Shannon Dunlap, Atlantic Richfield Company

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100% post-consumer paper & 100% vegetable-based inks

BUTTE-SILVER BOW
OLD LANDFILL FACILITY GROUNDWATER SAMPLING AND ANALYSIS PLAN (SAP)

Prepared for:

Butte-Silver Bow
Department of Public Works
126 W. Granite
Butte, Montana 59701

Prepared by:

Pioneer Technical Services, Inc.
P. O. Box 3445
Butte, Montana 59702

March 13, 2009

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) presents the sampling procedures, laboratory analytical methods, and Quality Assurance/Quality Control (QA/QC) procedures applicable to the routine groundwater monitoring activities at the Old Butte-Silver Bow Municipal Landfill/Clark Tailings Facility (Old Landfill). The procedures identified in this SAP are intended to meet the regulatory requirements outlined in the Montana Solid Waste Management Regulations (Administrative Rules of Montana [ARM] 17.50.708).

1.1 PURPOSE AND OBJECTIVES

The objectives of the groundwater monitoring activities at the Old Landfill are as follows:

1. Document and monitor background groundwater quality;
2. Document approved methods to sample and analyze groundwater which provides data that are complete, precise, accurate and defensible; and
3. Document the procedures to continue assessment monitoring as outlined in ARM 17.50.710.

2.0 BACKGROUND

2.1 LOCATION

The Old Landfill is located approximately 1 mile southwest of the city of Butte and covers approximately 130 acres (Figure 1). The site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County. The Old Landfill is accessed by traveling west to Butte, Montana, on U.S. Interstate 90 (I-90) and exiting at exit ramp 126, and then turning south on Montana Street. After traveling approximately 0.65 miles on Montana Street, a turn is made to the southwest onto Beef Trail Road, which is followed for approximately 0.5 miles where a turn is made to the east into the Copper Mountain Sports and Recreation Complex, which overlies the Old Landfill. The Copper Mountain Sports and Recreation Complex is composed of baseball diamonds, a walking trail, football/soccer fields, a children's playground, sand volleyball courts, and a driving range.

2.2 SITE HISTORY

The Old Landfill opened in approximately 1968 and accepted municipal solid waste from Butte and its vicinity and was issued an operating license by the Montana Department of Environmental Quality (DEQ) in 1978 (a permit was not required previously). The Old Landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). It is estimated that approximately 600,000 tons of refuse had been disposed of at the site (Pioneer, 1997). During November 1990, the DEQ conducted a Preliminary Assessment (PA) of the Landfill in accordance with the National Contingency Plan (NCP). The site did not score high enough to be included as a Superfund site. In July 1992, Butte-Silver Bow was notified by DEQ that a Groundwater Monitoring Plan and a

Groundwater SAP were required at the Landfill. Wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Well locations are shown on Figure 2. Ensuing groundwater sampling events detected constituents on the ARM 17.50.708 (Table 1) list of analytes that exceeded specified action levels. Accordingly, assessment monitoring was conducted and subsequent samples were analyzed for Table 2 constituents. Assessment monitoring results showed that groundwater protection standards (GWPS) were exceeded for certain volatile organic compounds (VOCs) and thallium. Groundwater monitoring has been conducted biannually since that time. Landfill capping and passive gas venting as a corrective measure was approved on March 21, 1997. Remedial construction began in 1997 and was completed in 1998.

The Clark Tailings consisted of a 60-acre impoundment with approximately 1,000,000 cubic yards (cy) of mill tailings (Hydrometrics, 1983) immediately adjacent to and partially mixed with the Landfill. The mixed nature of the wastes necessitated a combined Superfund and the Resource Conservation and Recovery Act (RCRA) response action be performed under RCRA jurisdiction.

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During its years of operation, the mill served primarily as a zinc and copper concentrator. The Clark Tailings were reclaimed in the mid-1980s as part of the "Clark Tailings Erosion Control Project," by the Anaconda Minerals Company; however, vegetation recovery was sparse in many areas and it was determined that additional reclamation was necessary. During reclamation of the Colorado Tailings in the Lower Area One Operable Unit in the Butte Silver-Bow Superfund Site, approximately 800,000 cy of tailings were placed in a repository constructed at the Clark Tailings.

The final RCRA repository cover for the Old Landfill was designed in 1997 and constructed in 1997 and 1998. The Copper Mountain Recreational Complex was included as part of the final design and today the reclaimed area has several irrigated baseball and football fields, a walking trail, a children's playground and sand volleyball courts.

Analytical data from all past monitoring activities are available in hard-copy form at the Butte-Silver Bow Public Works office located at 126 W. Granite Street in Butte, Montana. Data records (in electronic and hard-copy format) are also available at the office of Pioneer Technical Services, Inc. (Pioneer), located at 63½ W. Broadway Street in Butte, Montana.

3.0 SAMPLING AND ANALYSIS

3.1 GROUNDWATER MONITORING SCOPE

The scope of this SAP is limited to the sampling of six wells, three groundwater monitoring wells currently located within the Old Landfill, BSB-A1, BSB-A5 and BSB-A6R (Figure 3), a monitoring well located on Butte-Silver Bow land just west of the Old Landfill (MBMG-2), a monitoring well located on the northwest corner of the Old Landfill and in the right-of-way of

Little Basin Creek Road (CLK-2), and a monitoring well located on private property east of the Old Landfill boundaries (CLK-1). Keys for the well locks are located at Pioneer's main office located at 63½ W. Broadway in Butte, Montana, and also at the Parrot field office in Butte, Montana. Wells BSB-A1, BSB-A5, MBMG-2, BSB-A6R and CLK-2(Figure 3), located on Butte-Silver Bow land are accessed between the hours of 8:00 a.m. and 10:00 p.m. (these are the hours that Copper Mountain Park is open to the public). Static water levels will be measured in each of these wells on a semi-annual basis, in approximately March and September to document depth-to-groundwater and groundwater flow direction. Additionally, groundwater samples will be collected from the six wells on a semi-annual basis. These samples will be analyzed in compliance with the assessment monitoring requirements listed in ARM 17.50.710.

One monitoring well (MBMG-2) is located cross gradient from the facility and is considered the background well (to document background groundwater quality). The remaining five wells (BSB-A1, BSB-A5, BSB-A6R, CLK-1 and CLK-2) are designated as "monitoring wells." Table 1 provides installation specifications (diameter, total depth, etc.) for each of the wells, order in which wells are to be sampled and also lists the sample number that is assigned to each well when monitoring activities are conducted.

3.2 BUTTE-SILVER BOW LANDFILL GROUNDWATER MONITORING WELLS

Monitoring well MBMG-2 is located to the west of the Old Landfill (Figure 2). This well is located cross gradient from all reclamation activities that occurred at the Old Landfill. Sampling activities at this well involve recording the static water level followed by purging using low flow techniques (see Appendix A) with a variable speed pump and Teflon tubing. A minimum of 3 casing volumes purged or 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, specific conductance [SC], dissolved oxygen [DO] and oxidation-reduction potential [eH]) are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%. Samples from MBMG-2 are submitted for the following analyses: VOCs; semi-volatile organic compounds (SVOCs); organochlorine pesticides; polychlorinated biphenyls (PCBs); chlorinated herbicides; dissolved metals; chloride; chemical oxygen demand (COD); conductivity; cyanide; nitrate/nitrite; pH; and sulfate. During the March sampling event, a sample is also analyzed for sulfide (Table 2).

Monitoring well BSB-A1 is located near the northwest corner of the Old Landfill boundaries and downgradient of the historic disposal area (Figure 2). Sampling activities at this well involve recording the static water level followed by purging using low flow techniques (see Appendix A) with a variable speed pump and Teflon tubing. A minimum of 3 casing volumes purged or 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO and eH] are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%. Samples from BSB-A1 are submitted for the following analyses: VOCs; SVOCs; organochlorine pesticides; PCBs;

chlorinated herbicides; chloride; COD; conductivity; cyanide; nitrate/nitrite; pH; and sulfate. During the March sampling event, a sample is also analyzed for sulfide (Table 2).

Monitoring well BSB-A5 is located on the north edge of the former Clark Tailings (Figure 2). It is located cross gradient from the historic tailings impoundment and downgradient of the former landfill disposal areas. Sampling activities at this well involve recording the static water level followed by purging with a dedicated double check ball Teflon bailer. A minimum of three casing volumes are purged prior to sampling. Due to poor recharge, the well is often purged dry during the initial purging. The well is allowed to sit and is sampled over the next eight hours as recharge occurs. This well is often dry during the March sampling event. Field parameters (temperature, pH, SC, DO and eH) are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%. Samples from BSB-A5 are submitted for the following analyses: VOCs; SVOCs; organochlorine pesticides; PCBs; chlorinated herbicides; chloride; COD; conductivity; cyanide; nitrate/nitrite; pH; and sulfate. If water is present during the March sampling event, a sample is collected for sulfide analysis (Table 2). When sufficient water for all analysis cannot be collected, the sample containers will be collected in the following order: VOCs; raw (chloride, sulfate, COD, pH, and SC); SVOCs; nitrate/nitrite; chlorinated herbicides; organochlorine pesticides and PCBs; cyanide; sulfide; and field parameters.

Monitoring well BSB-A6R is located near the center of the Copper Mountain Sports and Recreation Facility (Figure 3). Monitoring well BSB-A6R was installed in 2001 to replace monitoring well BSB-A6, which was removed during reclamation. Sampling activities at this well involve recording the static water level followed by purging using low flow techniques (see Appendix A) with a variable speed pump and Teflon tubing. A minimum of 3 casing volumes purged or 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Samples are collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO and eH) are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from BSB-A6R are submitted for the following analyses: VOCs; SVOCs; organochlorine pesticides; PCBs; chlorinated herbicides; chloride; COD; conductivity; cyanide; nitrate/nitrite; pH; and sulfate (Table 2). During the March sampling event, one sample is also analyzed for sulfide.

Monitoring well CLK-1 is located on the northeast side of the original Clark Tailings on private property (Figure 2). Sampling activities at this well involve recording the static water level followed by purging with a 12-volt submersible pump and Tygon tubing. A minimum of 3 casing volumes purged or 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. After the well is appropriately purged, the sample is collected by pumping water directly from the tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO and eH) are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from CLK-1 are submitted for the following analyses: dissolved metals; chloride; conductivity; ph; and sulfate (Table 2).

Monitoring well CLK-2 is located on the north end of the original Clark Tailing complex and is downgradient of the Old Landfill (Figure 2). Sampling activities at this well involve recording the static water level followed by purging with a 12-volt submersible pump and Tygon tubing. A minimum of 3 casing volumes purged or 3 consecutive readings of the appropriate field parameters within 10% are required prior to sampling. Flow is restricted to approximately 0.25 gallons per minute during purging to prevent the well from going dry. Recharge on this well is poor and generally the well is purged dry immediately after three well volumes are purged. The well is allowed to recharge and the sample is collected directly from the pump tubing into the appropriate sample containers. Field parameters (temperature, pH, SC, DO and eH) are recorded using the Field Parameter Form (see Appendix B) at regular intervals during the purging process until 3 consecutive readings of the field parameters are within 10%.

Samples from CLK-2 are submitted for the following analyses: dissolved metals; chloride; conductivity; ph; and sulfate (Table 2).

3.3 GROUNDWATER MONITORING PROCEDURES

During each semi-annual sampling event, depth-to-groundwater (static water level) is measured at the specified measuring point on each well casing using an electronic probe. This information is recorded in the field logbook. A dedicated double check valve Teflon bailer is used to purge and sample BSB-5. A decontaminated variable speed 12-volt submersible pump and Teflon tubing is used for low-flow (see Appendix A) purging and sampling of MBMG-2, BSB-1, BSB-A6R. Since organic samples are not collected from CLK-1 and CLK-2, a decontaminated variable speed 12-volt submersible pump and Tygon tubing is used to sample these wells. If possible, a minimum of three well casing volumes is purged before samples are collected. Samples are collected from each well only after one of the following purge conditions is met:

- The well is bailed or pumped dry and allowed to recover sufficiently so that an adequate volume of water for collecting samples can be removed;
- More than three well casing volumes have been purged; or
- Field parameters have stabilized. Stabilization is defined as 3 consecutive readings of temperature, pH, SC within 10%.

Following well purging procedures, water quality samples are collected. Sample containers are filled directly from the pump or by pouring directly from the bailer into the appropriate sample containers. When a pump is used to collect the sample, the water flow is reduced to provide a steady, non-aerated flow while purging and filling the sample bottles. When a bailer is used to collect the sample, the bailer is inverted slightly to provide a steady, non-aerated flow while filling the bottles. Field parameters (SC, pH, DO, temperature, and eH) are collected during purging prior to sample collection and are recorded in the Field Parameter Form (Appendix B).

The samples are analyzed in compliance with the assessment monitoring requirements listed in ARM 17.50.708. Table 3 contains an entire list of the following analyses:

- Dissolved metals (see Table 3 for complete list);
- Cyanide;
- Chloride;
- Nitrate (as N);
- Sulfate;
- COD;
- pH;
- SC;
- VOCs, including Acrylonitrile (EPA Method 8260);
- Acid and Base Extractables, SVOCs (EPA Method 8270);
- Chlorinated Herbicides (EPA Method 8151); and
- Organochlorine Pesticides and PCBs (EPA Method 8081).

Samples for dissolved metals analyses are filtered by one of the following methods:

- If the sample is collected using a bailer, the water is transferred to a clean sample container and then pumped from the sample bottle through a new disposable hi-volume filter capsule (0.45 microns [µm]), into a second sample container using a peristaltic pump and disposable tubing. After filtering, the sample is preserved using the appropriate preservative.

- If the sample is collected using a pump, a new disposable hi-volume filter capsule (0.45 µm) is attached to the pump tubing (effluent), and the water is pumped through the filter directly into the sample container. After filtering, the sample is preserved using the appropriate preservative.

Following collection, all samples are preserved using the appropriate preservative for the intended analysis. The appropriate containers, preservatives, laboratories, and holding times for the analyses are presented in Table 3. All samples are stored with ice in coolers for transport to the office or to the laboratory. Samples are stored in coolers or are refrigerated from the time of collection until delivery to the analytical laboratory. Strict chain of custody procedures (see Appendix B, Standard Operating Procedures) are adhered to at all times.

3.3.1 Sample Identification

Alpha-numeric sample identification codes are assigned to the groundwater samples collected from each well as indicated in Table 1. Sample identifiers are designated using the following procedure:

- BSB - Site code designating the site as the Old Landfill;
- GW- Sample media code designating that the sample type is groundwater; and
- Location code designating the well (Table 2 indicates which location code is associated with each well).

3.3.2 Sample Preservation and Handling

All samples are preserved immediately following sample collection. Table 3 lists sample holding times, preservation methods, and appropriate containers, etc. All samples are stored in coolers (with ice) at approximately 4 ± 2 degrees Celsius (°C) during transport. The samples are stored in coolers (on ice) or are refrigerated from the time of collection until delivery to the analytical laboratory. Samples for organic and inorganic analyses are shipped via the United Parcel Service (UPS) within 24 hours of sampling to Energy Laboratories located in Billings, Montana. All samples are handled and transferred under strict chain of custody procedures. Custody seals are placed on shipped coolers to protect the integrity of the samples while in transit to the laboratory. The laboratory disposes of any sample portion not used for analysis, in accordance with their sample disposal policy.

3.3.3 Supplies and Equipment

The required supplies and equipment necessary to complete the monitoring procedures addressed in this SAP are listed in Table 4. The items are broken down into two main categories: groundwater monitoring equipment/supplies and health and safety supplies.

3.3.4 Instrument Calibration

All portable meters are calibrated daily in accordance with the manufacturer's instructions issued with the equipment and Pioneer's Standard Operating Procedures (SOPs). Calibration results are recorded in the field logbook.

3.3.5 Documentation

All sampling activities and field data collection are recorded in a bound field logbook dedicated to groundwater monitoring activities at the Old Landfill. All applicable logbook entries are completed prior to proceeding to the next sampling site. The Field Team Leader is responsible for recording information including, but not necessarily limited to, the following: date and time of sample collection; weather conditions; field crew members; samples collected (including appropriate sample identifier); procedures used; field data collected using Field Parameters Form (see Appendix B); and any deviations from this SAP. Chain of custody forms are completed in accordance with Pioneer's SOP (PTS-SOP-SA-04).

3.3.6 Decontamination Procedures

The Old Landfill is considered low risk for contaminant exposure to the field team members. However, a complete Health and Safety Plan (HASP) has been developed for the site (see Appendix C) and all personnel are subject to decontamination procedures when leaving a contaminated area for their own protection (in accordance with SOPs [Appendix B]). Personnel decontamination includes routine practices and emergency decontamination. All project personnel will take measures to prevent the spread of potentially hazardous materials to clean areas. All sampling equipment and personal protective materials generated on-site will be containerized and disposed of properly. Purge water is disposed of on the ground adjacent to each well. Due to the contaminations in wells BSB-A6R and CLK-1, purge water from these wells will be containerized and disposed of according to federal, state and local requirements.

All reusable equipment is decontaminated after each use (in accordance with SOPs). Decontamination procedures are applicable to the electronic probes for the static water level indicator, pH meter, SC meter, DO meter, and eH meter. Visible contamination is wiped off with a paper towel and then the probes are thoroughly sprayed with de-ionized water and dried with paper towel.

4.0 DEQ NOTIFICATION

A minimum of 14 days prior to each sampling event, written notification will be provided to the DEQ Solid Waste Regulatory Program. Letter, fax or e-mail notification is acceptable. Contact information for the notification is as follows:

Solid Waste Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901
Fax: 406-444-1374

5.0 GROUNDWATER MONITORING SCHEDULE

Groundwater monitoring will occur semi-annually, during high and low groundwater conditions. Sampling events will generally occur six months apart in March and September, depending on weather and site access conditions. The monitoring work outlined under this SAP is expected to take one day to complete per each monitoring event.

6.0 LABORATORY AND FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLING

6.1 FIELD GENERATED QA/QC SAMPLES

Field QC protocols will be consistent with Pioneer's SOPs and will include the following annually (at a minimum): one field duplicate and one field blank.

The field duplicate is generated in the field by collecting two samples from one groundwater sample location at the same time. The field duplicate is analyzed for dissolved metals, VOCs, chloride, conductivity, pH, and sulfate. The field blank is generated in the field by pouring purified water directly into appropriate sample containers. The field blank is analyzed for dissolved metals, chloride, conductivity, pH, sulfate, and VOCs.

The field duplicate, as described above, is used to verify the reproducibility of the monitoring data. The field blank, as described above, is used to verify the quality of the laboratory data and the cleanliness of the sample containers.

7.0 LABORATORY GENERATED QA/QC SAMPLES

Laboratory QA/QC samples are generated at a rate of 5% (1 per 20 analytical samples) or 1 per submitted batch; whichever is more frequent. Laboratory QA/QC samples include the preparation blank (PB), which is used to assess laboratory contamination and analytical bias near the limit of detection; and the laboratory control sample (LCS), which is used to determine accuracy of the preparatory steps and analysis. Additionally, laboratory duplicates or matrix spike duplicates are utilized to determine precision of the preparatory steps and analyses. Matrix spike samples consist of spiking the sample matrix with a known amount of analyte. The recovery of the analyte from the spiked sample matrix is used to assess the interferences present in the sample. These are the minimum QA samples utilized by the laboratory to monitor preparation and analysis. Other QA samples are run during instrumental analyses to monitor the accuracy and ongoing precision (drift) during the analytical run. All of the QA samples are not appropriate for every determinative method; however, as many of the QA sample types are applied to each method when possible. A typical summary of the Energy Laboratories QA Program is included in Appendix D.

8.0 ANALYTICAL METHODS

Groundwater samples collected from MBMG-2, BSB-A1, BSB-A5, and BSB-A6R are analyzed for VOCs, SVOCs, organopesticides, PCBs, chlorinated herbicides, chloride, COD, conductivity, cyanide, nitrate/nitrite, pH, and sulfate. In addition, the four previously mentioned wells are analyzed for sulfide during the March sampling event. Groundwater samples collected at MBMG-2, CLK-1, and CLK-2 are analyzed for dissolved metals, chloride, conductivity, nitrate/nitrite, pH and sulfate (Table 2). The specific methods that are applicable to each analysis are presented in Table 3.

9.0 DATA MANAGEMENT AND STATISTICAL ANALYSIS

All analytical data generated for groundwater monitoring at the Old Landfill are entered and stored on a Microsoft EXCEL spreadsheet and in a STATISTIX database. The EXCEL spreadsheet and STATISTIX database is updated and maintained at Pioneer's Butte, Montana, office. The EXCEL spreadsheet allows for simple access to all historic information. Additionally, hard copies of all laboratory reports are filed at Pioneer's Butte, Montana, office as well as at the Butte-Silver Bow Public Works office for cross-referencing, as necessary.

Prior to reporting the data to the DEQ for each monitoring event, the distribution of the background data (normal, in-normal or non-normal) will be determined prior to statistical analysis. If the data are determined to be normally distributed the data is subjected to a parametric analysis of variance (ANOVA). This is followed by multiple comparison procedures using the STATISTIX database and software to identify statistically significant evidence of contamination, including estimation and testing of contrasts between each compliance well's mean/median and the background mean/median levels for each constituent as described in the ARM 17.50.708.12(a) and 12(b).

If the data are determined to be non-normal, a non-parametric prediction interval statistical analysis, as stipulated by DEQ in 2000 (see letter contained in Appendix E) is used to compare current monitoring data to background and baseline (intra-well) conditions.

10.0 REPORTING

When analytical reports are received from the laboratory for each monitoring event (typically 3 to 6 weeks following the monitoring event), the data are tabulated and subjected to a statistical analysis as described in Section 9.0. All information related to the monitoring event is then compiled and a letter report is submitted within 90 days of sampling as required by ARM 17.50.708(15) to the DEQ's Solid Waste Program and Gary Keeler at the Butte-Silver Bow Public Works Department. This report includes the following information:

- Groundwater field parameters measured in the field;
- Copies of the field logbook entries;
- Groundwater potentiometric surface map including flow direction;
- Calculation and discussion of the groundwater flow rate;
- Statistical analysis;
- Organic analytical data reports (including QA/QC results) from Energy Laboratories in Billings, Montana;
- Inorganic analytical data reports (including QA/QC results) from MSE Laboratory, Inc. in Butte, Montana;
- A narrative of the sampling event noting any deviations from the SAP; and
- A comparison of the data to regulatory standards, as appropriate.

11.0 REFERENCES

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FIGURES

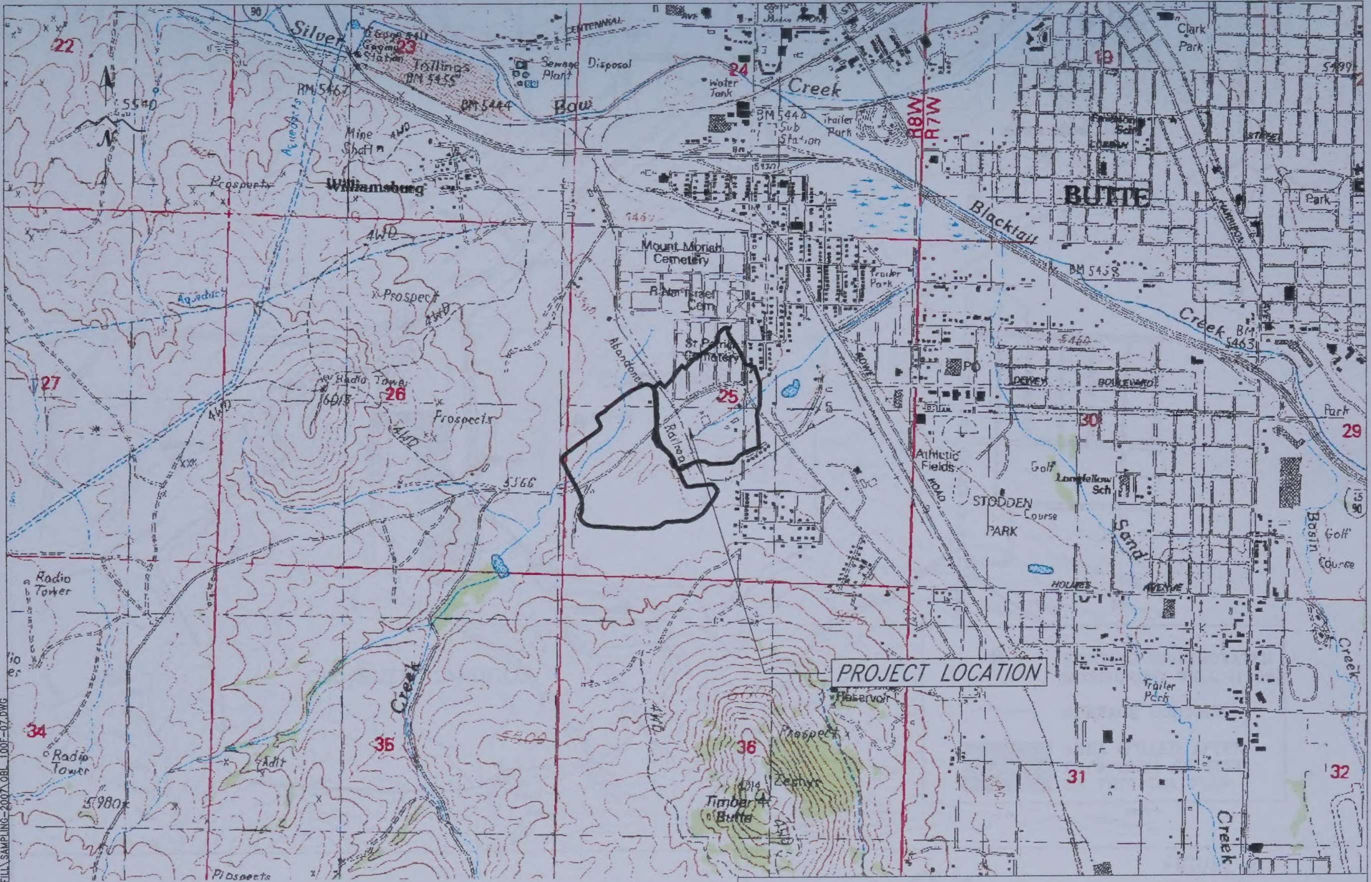
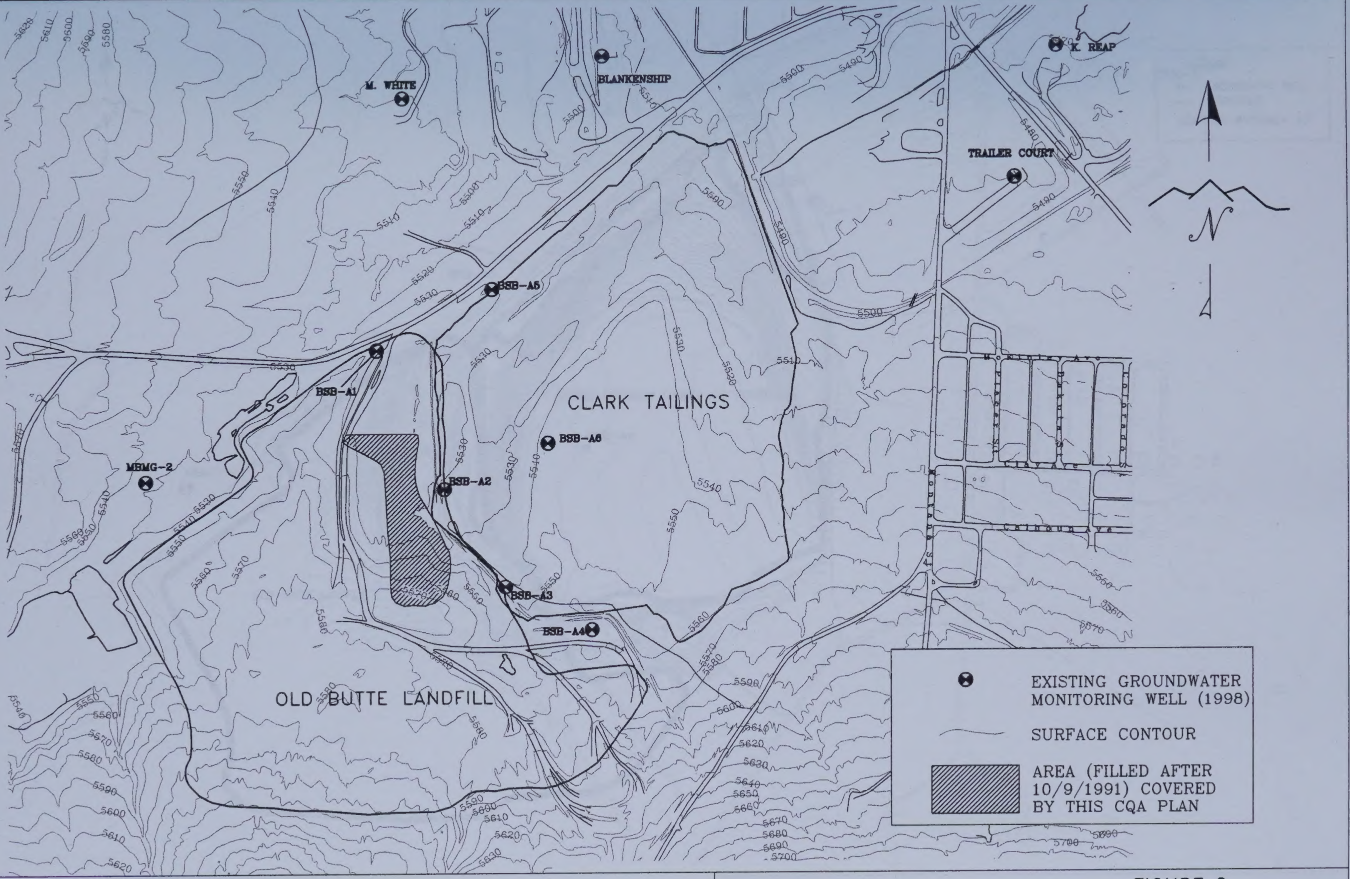

Silver
Tailings
Sewage Disposal Plant
Bow
Creek
Water Tank
Sub Station
Trailer Park
R8W
R7W
Clark Park
BUTTE
Blacktail
Creek
Park
Williamsburg
Mine Shaft
Prospects
Aqueduct
Mount Moriah Cemetery
B'nai Israel Cem
St Patrick Cemetery
Prospect
Radio Tower
Prospects
Abandoned
Railroad
Athletic Fields
STODDEN PARK
Golf Course
Longfellow Sch
Sand
Creek
Basin
Golf Course
Radio Tower
Creek
Adit
Reservoir
Prospect
Zephyr
Timber Butte
PROJECT LOCATION
Prospects
22
23
24
19
27
26
25
30
29
34
35
36
31
32

FIGURE 1
GENERAL LOCATION MAP
OLD BUTTE LANDFILL SITE

PIONEER TECHNICAL SERVICES, INC.

SCALE: 1"=2000'
DATE: 2/14/07

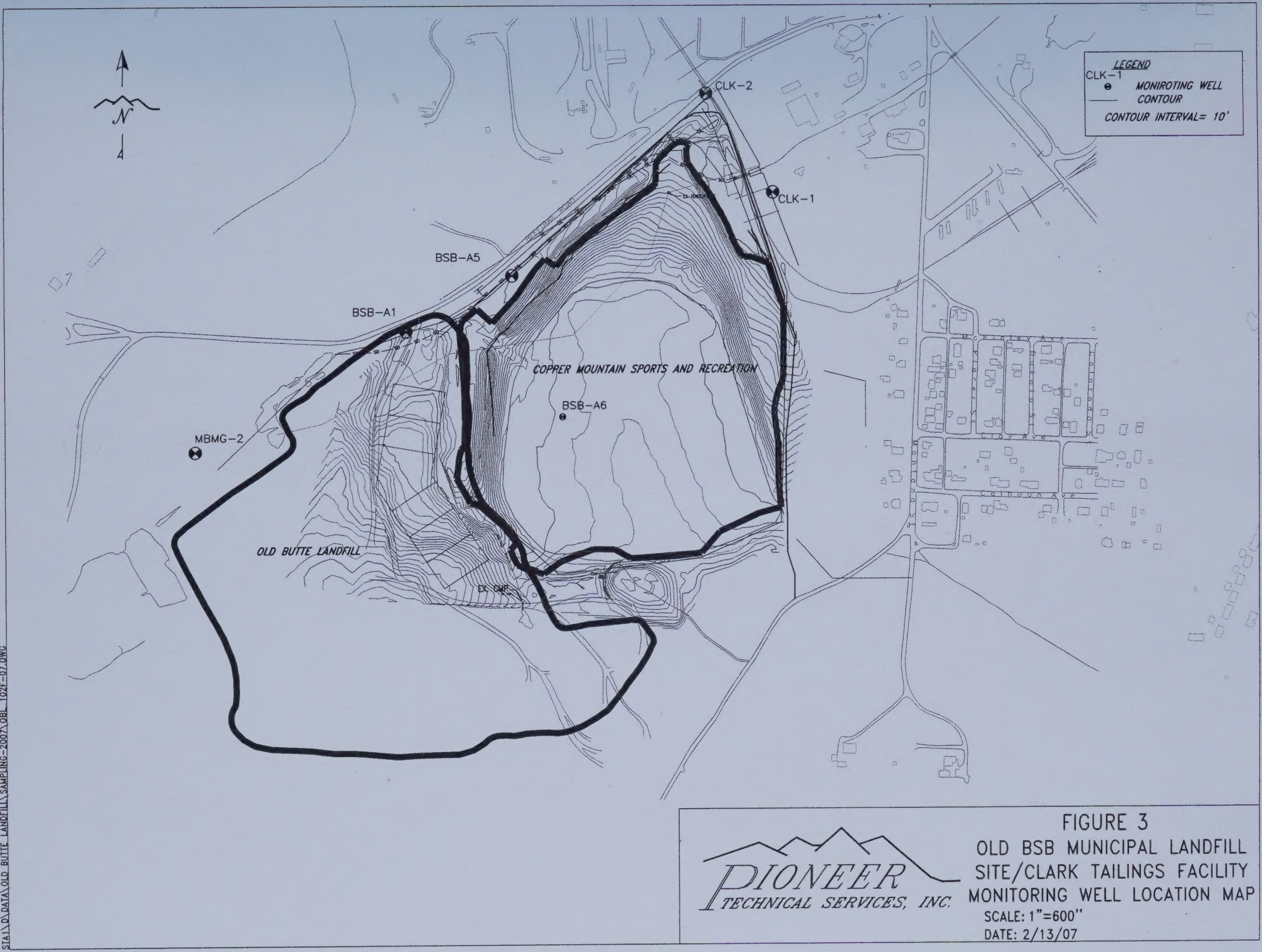
STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2007\OBL_100F-07.DWG


M. WHITE
BLANKENSHIP
K. REAP
TRAILER COURT
BSB-A1
BSB-A2
BSB-A3
BSB-A4
BSB-A5
BSB-A6
MBMG-2
CLARK TAILINGS
OLD BUTTE LANDFILL
N
McKinley Ave
Placer St
Dakota St
Colorado
Clay Ave
Calhoun Ave
Montana St
5620
5610
5600
5590
5580
5550
5540
5530
5520
5510
5500
5490
5480
5460
5560
5570
5630
5640
5650
5660
5670
5680
5690
5700
EXISTING GROUNDWATER MONITORING WELL (1998)
SURFACE CONTOUR
AREA (FILLED AFTER 10/9/1991) COVERED BY THIS CQA PLAN

PIONEER TECHNICAL SERVICES, INC.

FIGURE 2
OLD BSB MUNICIPAL LANDFILL SITE
CLARK TAILINGS FACILITY MONITORING
WELL LOCATION MAP JUNE 1998
SCALE: 1"=600'
DATE: 2/13/07

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2007\OBL 102F-07.DWG


N
CLK-2
CLK-1
BSB-A5
BSB-A1
BSB-A6
MBMG-2
COPPER MOUNTAIN SPORTS AND RECREATION
OLD BUTTE LANDFILL
EX CMP
McKinley Ave
Clay Ave
Calhoun Ave
LEGEND
CLK-1
MONIROTING WELL
CONTOUR
CONTOUR INTERVAL= 10'

PIONEER TECHNICAL SERVICES, INC.

FIGURE 3
OLD BSB MUNICIPAL LANDFILL SITE/CLARK TAILINGS FACILITY MONITORING WELL LOCATION MAP

SCALE: 1"=600'
DATE: 2/13/07

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2007\OBL 102E-07.DWG

TABLES

TABLE 1
OLD LANDFILL GROUNDWATER WELL INFORMATION

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)[1]	TOC Elevation (ft)	Groundwater Elevation (ft)[1]
MBMG-2	BSB-GW-01	23.25	0.17	14.69	5529.88	5515.19
BSB-A1	BSB-GW-02	57.00	0.17	36.34	5531.50	5495.16
BSB-A5	BSB-GW-03	46.50	0.17	41.85	5524.62	5482.77
BSB-A6-R	BSB-GW-04	59.75	0.17	52.33	5554.41	5502.08
CLK-1	BSB-GW-05	19.00	0.17	4.94	5478.73	5473.79
CLK-2	BSB-GW-06	46.90	0.17	40.89	5511.17	5470.28

[1] As measured in September 2006

Well I.D.	Sample Number	Sample Type	e/ e	Organochloride and PCB	Chlorinated Herbicides	Sulfide (March Event Only)
MBMG-2	BSB-GW-01	Natural		X	X	X
BSB-A1	BSB-GW-02	Natural		X	X	X
BSB-A5	BSB-GW-03	Natural		X	X	X
BSB-A6-R	BSB-GW-04	Natural		X	X	X
BSB-A6-R	BSB-GW-07	Duplicate				
CLK-1	BSB-GW-05	Natural				
CLK-2	BSB-GW-06	Natural				
CLK-2	BSB-GW-08	Duplicate				
	BSB-GW-09	Field Blank				

[1] As measured in September 2006

Well I.D.	Sample Number	Sample Type	e/ e	Organochloride and PCB	Chlorinated Herbicides	Sulfide (March Event Only)
MBMG-2	BSB-GW-01	Natural		X	X	X
BSB-A1	BSB-GW-02	Natural		X	X	X
BSB-A5	BSB-GW-03	Natural		X	X	X
BSB-A6-R	BSB-GW-04	Natural		X	X	X
BSB-A6-R	BSB-GW-07	Duplicate				
CLK-1	BSB-GW-05	Natural				
CLK-2	BSB-GW-06	Natural				
CLK-2	BSB-GW-08	Duplicate				
	BSB-GW-09	Field Blank				

[1] As measured in

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TABLE 2
OLD LANDFILL GROUNDWATER WELL SAMPLING INFORMATION

Well I.D.	Sample Number	Sample Type	Depth (ft)	Radius (ft)	S.W.L. (ft)[1]	H2O Volume Req'd (gal)[1]	Field Parameters	Dissolved Metals	VOC	Chloride, SC, pH, Sulfate	COD	Cyanide	Nitrate/ Nitrite	Organochloride and PCB	Chlorinated Herbicides	Sulfide (March Event Only)
MBMG-2	BSB-GW-01	Natural	23.25	0.17	14.69	4.28	X	X	X	X	X	X	X	X	X	X
BSB-A1	BSB-GW-02	Natural	57.00	0.17	36.34	10.33	X		X	X	X	X	X	X	X	X
BSB-A5	BSB-GW-03	Natural	46.50	0.17	41.85	2.33	X		X	X	X	X	X	X	X	X
BSB-A6-R	BSB-GW-04	Natural	59.75	0.17	52.33	3.71	X		X	X	X	X	X	X	X	X
BSB-A6-R	BSB-GW-07	Duplicate							X							
CLK-1	BSB-GW-05	Natural	19.00	0.17	4.94	7.03	X	X		X						
CLK-2	BSB-GW-06	Natural	46.90	0.17	40.89	3.01	X	X		X						
CLK-2	BSB-GW-08	Duplicate						X		X						
	BSB-GW-09	Field Blank						X	X	X						

[1] As measured in September 2006

TABLE 3
MONTANA ARM 17.50.708 TABLE 2 CONSTITUENTS
ANALYTICAL METHODS, REPORTING LIMITS, HOLDING TIMES, PRESERVATION METHOD AND CONTAINER TYPE

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Physical Properties							
Cyanide	Distillation / Spectrophotometry	EPA 335.2	0.005	14 days	NaOH; pH>12, cool 4°C	500 ml Plastic / HDPE	MSE Laboratories
pH	Potentiometric	EPA 150.1	0.1 SU	24 hours	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Chemical Oxygen Demand (COD)	Spectrophotometry	EPA 410.4	10	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Specific Conductance (SC)	Potentiometric	EPA 120.1	1 umhos/cm	28 days	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Inorganics (Anions)							
Chloride	IC	EPA 300.0	5	28 days	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Sulfate	IC	EPA 300.0	5	28 days	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Sulfide	Idometric Method	4500-S2-F	1	7 days	zinc actetate/sodium hydroxide,cool 4°C	1L Plastic / HDPE	MSE Laboratories
Nutrients							
Nitrate / Nitrite-N	Spectrophotometry	EPA 353.2	0.05	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Nitrate / Nitrite-N	IC	EPA 300.0	0.05	48 hours	None	250 ml Plastic / HDPE	MSE Laboratories
Dissolved Metals							

methylene chloride					HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Styrene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,1,2-Tetrachloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,2,2-Tetrachloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Tetrachloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Toluene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,1-Trichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,2-Trichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Trichloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Trichlorofluoromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2,3-Trichloropropane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Vinyl acetate	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Vinyl chloride	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
m+p-Xylenes	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
o-Xylene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Xylenes, Total	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
ICP-AES - Inductively coupled atomic emission spectrometry

GC/MS - Gas chromatograph/mass spectrometer
GC/ECD - Gas chromatograph/electron capture detector
SM - Standard Methods for the Examination of Water and Wastewater
NC - No Charge

[1] - includes bicarbonate, carbonate, & hydroxide

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pH	Potentiometric	EPA 150.1	0.1 SU	24 hours	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Chemical Oxygen Demand (COD)	Spectrophotometry	EPA 410.4	10	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Specific Conductance (SC)	Potentiometric	EPA 120.1	1 umhos/cm	28 days	cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Inorganics (Anions)							
Chloride	IC	EPA 300.0	5	28 days	ool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Sulfate	IC				l 4°C	250 ml Plastic / HDPE	MSE Laboratories
					ate/sodium e,cool 4°C	1L Plastic / HDPE	MSE Laboratories
					<2, cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
					ne	250 ml Plastic / HDPE	MSE Laboratories
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings
					H<2, cool 4°C	2-40 ml glass vials	Energy-Billings

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Nutrients							
Nitrate / Nitrite-N	Spectrophotometry	EPA 353.2	0.05	28 days	H_2SO_4; pH<2, cool 4°C	250 ml Plastic / HDPE	MSE Laboratories
Nitrate / Nitrite-N	IC	EPA 300.0	0.05	48 hours	None	250 ml Plastic / HDPE	MSE Laboratories
Dissolved Metals							
Antimony	ICP-MS	SW 6020	0.003	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Arsenic	ICP-MS	SW 6020	0.001	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Barium	ICP-AES	SW 6010	0.005	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Beryllium	ICP-MS	SW 6020	0.001	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Cadmium	ICP-MS	SW 6020	0.0001	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Chromium	ICP-AES	SW 6010	0.02	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Cobalt	ICP-AES	SW 6010	0.02	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Copper	ICP-AES	SW 6010	0.003	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Iron	ICP-AES	SW 6010	0.015	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Lead	ICP-MS	SW 6020	0.001	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Mercury	CVAAS	SW 7470	0.0001	28 days	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Nickel	ICP-AES	SW 6010	0.02	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Selenium	ICP-MS	SW 6020	0.002	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Thallium	ICP-MS	SW 6020	0.00001	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Vanadium	ICP-AES	SW 6010	0.003	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Silver	ICP-AES	SW 6010	0.005	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
Zinc	ICP-AES	SW 6010	0.01	6 months	HNO3; pH<2, cool 4°C	1L Plastic / HDPE	MSE Laboratories
VOC							
Acrylonitrile	GC/MS	SW8260B	20	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Benzene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Bromochloromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Bromodichloromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Bromoform	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Bromomethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Carbon disulfide	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Carbon tetrachloride	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Chlorobenzene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Chlorodibromomethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Chloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Chloroform	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Chloromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2-Dibromo-3-chloropropane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2-Dibromoethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Dibromomethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2-Dichlorobenzene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,4-Dichlorobenzene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
trans-1,4-Dichloro-2-butene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Dichlorodifluoromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1-Dichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2-Dichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1-Dichloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
cis-1,2-Dichloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
trans-1,2-Dichloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2-Dichloropropane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
cis-1,3-Dichlopopropene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
trans-1,3-Dichloropropene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Ethylbenzene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
2-Hexanone	GC/MS	SW8260B	20	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Iodomethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Methyl ethyl ketone	GC/MS	SW8260B	20	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Methyl isobutyl ketone	GC/MS	SW8260B	20	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
methylene chloride	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Styrene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,1,2-Tetrachloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,2,2-Tetrachloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Tetrachloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Toluene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,1-Trichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,1,2-Trichloroethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Trichloroethene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Trichlorofluoromethane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
1,2,3-Trichloropropane	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Vinyl acetate	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Vinyl chloride	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
m+p-Xylenes	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
o-Xylene	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings
Xylenes, Total	GC/MS	SW8260B	1.0	14 Days	HCL; pH<2, cool 4°C	2-40 ml glass vials	Energy-Billings

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
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GC/MS - Gas chromatograph/mass spectrometer
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SM - Standard Methods for the Examination of Water and Wastewater
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[1] - includes bicarbonate, carbonate, & hydroxide

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Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
SVOC							
4-Chloro-3-methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 2-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 3-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 4-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-Dichlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Nitrobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodi-n-propylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodimethylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodiphenylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Phenanthrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pyrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pyridine	GC/MS	SW 8270C	20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,2,4-Trichlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings

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MONTANA ARM 17.50.708 TABLE 2 CONSTITUENTS
ANALYTICAL METHODS, REPORTING LIMITS, HOLDING TIMES, PRESERVATION METHOD AND CONTAINER TYPES

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
SVOC							
4-Chloro-3-methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 2-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 3-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
		SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
			10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings
					Cool 4°C	2-1000 mL glass bottles	Energy-Billings

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TABLE 3
MONTANA ARM 17.50.708 TABLE 2 CONSTITUENTS
ANALYTICAL METHODS, REPORTING LIMITS, HOLDING TIMES, PRESERVATION METHOD AND CONTAINER TYPES

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
SVOC							
4-Chloro-3-methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Chlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 2-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 3-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Cresols: 4-Methylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-Dichlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-Dimethylphenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,6-Dinitro-2-methylphenol	GC/MS	SW 8270C	50	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-Dinitrophenol	GC/MS	SW 8270C	50	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Nitrophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Nitrophenol	GC/MS	SW 8270C	50	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pentachlorophenol	GC/MS	SW 8270C	50	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Phenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4,5-Trichlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4,6-Trichlorophenol	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Acenaphthene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Acenaphthylene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Anthracene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzo(a)anthracene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzidene	GC/MS	SW 8270C	20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzo(b)fluoranthene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzo(k)fluoranthene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzo(g,h,i)perylene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Benzo(a)pyrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Bis(2-chloroethoxy)methane	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Bis(2-chloroethyl)ether	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Bis(2-chloroisopropyl)ether	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Bis(2-ethylhexyl)phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Bromophenylphenylether	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Butyl benzyl phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Chloronaphthalene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4-Chlorophenyl-phenylether	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Chrysene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Di-n-butyl phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Di-n-octyl phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dibenzo(a,h)anthracene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,2-Dichlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,3-Dichlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,2-Dichlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
3,3'-Dichlorobenzidine	GC/MS	SW 8270C	20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Diethyl phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dimethyl phthalate	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-Dinitrotoluene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,6-Dinitrotoluene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,2-Diphenylhydrazine as Azobenze	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Fluorene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Fluoranthene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Hexachlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Hexachlorobutadiene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Hexachlorocyclopentadiene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Hexachloroethane	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Indeno(1,2,3-cd)pyrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Isophorone	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1-Methylnaphthalene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2-Methylnaphthalene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Naphthalene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Nitrobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodi-n-propylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodimethylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
N-Nitrosodiphenylamine	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Phenanthrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pyrene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pyridine	GC/MS	SW 8270C	20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
1,2,4-Trichlorobenzene	GC/MS	SW 8270C	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
ICP-AES - Inductively coupled atomic emission spectrometry
GC/MS - Gas chromatograph/mass spectrometer
GC/ECD - Gas chromatograph/electron capture detector
SM - Standard Methods for the Examination of Water and Wastewater
NC - No Charge

TABLE 3
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ANALYTICAL METHODS, REPORTING LIMITS, HOLDING TIMES, PRESERVATION METHOD AND CONTAINER TYPE

Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Organochlorine Pesticides and PCBs							
Aldrin	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
alph-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
beta-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
delta-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
gamma-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
alpha-chlordane	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
gamma-Chlordane	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDD	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDE	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDT	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings

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alph-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
[illegible]	[illegible]	[illegible]	[illegible]	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings

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TABLE 3

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Parameter	Method Type	Method	Approximate Reporting MDL (mg/L)	Holding Time	Preservation	Container / Type	Laboratory
Organochlorine Pesticides and PCBs							
Aldrin	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
alph-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
beta-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
delta-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
gamma-BHC	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
alpha-chlordane	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
gamma-Chlordane	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDD	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDE	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
4,4'-DDT	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dieldrin	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Endosulfan I	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Endosulfan II	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Endosulfan Sulfate	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Endrin	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Endrin Aldehyde	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Heptachlor	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Heptachlor Epoxide	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Isodrin	GC/ECD	SW 8081A	0.05	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Kepone	GC/ECD	SW 8081A	0.1	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Methoxychlor	GC/ECD	SW 8081A	0.5	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Chlordane	GC/ECD	SW 8081A	0.5	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Toxaphene	GC/ECD	SW 8081A	5.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
PCBs							
Aroclor-1016	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1221	GC/ECD	SW 8081A	2.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1232	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1242	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1248	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1254	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Aroclor-1260	GC/ECD	SW 8081A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Chlorinated Herbicides							
2,4-D	GC/ECD	SW 8151A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4-DB	GC/ECD	SW 8151A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dalapon	GC/ECD	SW 8151A	10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dicamba	GC/ECD	SW 8151A	0.25	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dichlorporp	GC/ECD	SW 8151A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Dinoseb	GC/ECD	SW 8151A	1.0	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4,5-TP (Silvex)	GC/ECD	SW 8151A	0.20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
2,4,5-T	GC/ECD	SW 8151A	0.20	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
MCPA	GC/ECD	SW 8151A	250	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
MCPP	GC/ECD	SW 8151A	250	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings
Pentachlorophenol	GC/ECD	SW 8151A	0.10	7	Cool 4°C	2-1000 mL glass bottles	Energy-Billings

Legend

EPA - U. S. Environmental Protection Agency
CVAAS - Cold vapor atomic absorption spectrophotometry
GFAAS - Graphite furnace atomic absorption spectrophotometry
IC - Ion chromatography
ICP-MS - Inductively coupled mass spectrometry
ICP-AES - Inductively coupled atomic emission spectrometry
GC/MS - Gas chromatograph/mass spectrometer
GC/ECD - Gas chromatograph/electron capture detector
SM - Standard Methods for the Examination of Water and Wastewater
NC - No Charge

TABLE 4

GROUNDWATER MONITORING FIELD EQUIPMENT LIST
BUTTE-SILVER BOW LANDFILL

SAMPLING SUPPLIES

Field Sampling Plan
Pioneer SOPs
Garbage Bags
Logbook
Sharpies
Pens
Federal Express/UPS Forms
Packing Material
1 Gallon Ziploc® bags
Electronic Surface Water Level Indicator
Keys for Well locks
Clear Tape
Sample Labels
DI Water
Spray Bottles
Calibration Solutions
SC Meter
DO Meter
Methanol
Duct Tape
12 Volt Submersible Pump
Calculator
Extra Teflon Bailers
Bailer String
Bucket
Stopwatch
Preservatives
Sample containers
Filters
Peristaltic Pump
Tubing
Blank Water
pH Meter
Batteries
Eh Meter
Coolers
Chain of Custody Forms and Seals Ice
Scissors/Knife
Paper Towels

SAFETY/PPE

Health and Safety Plan
First Aid Kit
Fire Extinguisher
Leather Gloves
Nitrile Gloves
Steel Toed Boots
Safety Glasses
Sunscreen
Insect Repellent
Drinking Water
Hearing Protection

APPENDIX A

DEQ MEMORANDUM
SRS LOW-FLOW PURGING AND SAMPLING GUIDELINES

Memorandum

To: DEQ SRS

From: Amy Sivers

Date: 4/18/2005

Re: **SRS Low-Flow Purging and Sampling Guidelines**

The following guidelines provide the basis for low-flow sampling protocol at Montana Department of Environmental Quality (DEQ) Site Response Section (SRS) facilities, unless site-specific and contaminant-specific conditions require alternate protocols be followed. If alternate protocols are proposed, the sampler must provide a detailed written justification for the deviation from these guidelines. If the sampler is other than DEQ, the sampler must obtain DEQ approval prior to commencing a low-flow sampling event or program. If the sampler implements a deviation from these guidelines, such deviation must be documented in writing where the resulting data are discussed, for example in the site investigation (SI) report or monitoring report, and also in the field log book or groundwater sampling log.

Low-flow sampling purges stagnant water out of the well to allow sampling of formation water; however it is intended to purge and sample only a limited interval of the well/formation column.

Applicability of Guidelines:
"Low-flow" purging and sampling is also called "minimum drawdown" and "low-stress" purging and sampling. This SRS guidance does not cover minimum-purge or no-purge sampling.

Guidelines:

1) Low-flow sampling is generally not appropriate for wells that contain light or dense non-aqueous phase liquids (LNAPL or DNAPL), and is not appropriate for collecting samples of LNAPL or DNAPL.
2) A positive displacement pump that allows for an adjustable pumping rate should be used for low-flow groundwater sampling under most conditions
    a. Suction pumps, such as peristaltic pumps, are inappropriate for collecting volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), volatile petroleum compounds and some (pH-dependent) metals, particularly in wells deeper than 10-15 feet, because of the potential for degassing and associated potential pH changes.

   b. Inertial pumps (such as Waterra) or bailers should never be used for low-flow sampling because they generate turbulence in the well.
   c. Dedicated pumps are preferable to portable pumps. Portable pumps may create disturbance in the water column during installation, and also require decontamination between wells.
   d. If a portable pump is used, new or dedicated tubing must be used at each sampling location, and the pump must be lowered gently into the well to minimize disturbance to the water column.

3) If a petroleum-powered generator is used to run the sampling pump, the power source must be located at least 10 feet downwind of the wellhead and sampling apparatus, and should be located at least 30 feet downwind if possible.
4) Pump intake must be in an appropriate location with respect to well screen.
   a. For most sites, and at wells with screens 10 feet long or shorter, the pump intake should be located at approximately the midsection of the saturated screened interval.
   b. For wells with screens longer than 10 feet, the primary flow zones and contaminant concentration intervals must be identified and pump intake location must be determined in consultation with SRS.
   c. For sites with intervals of different contaminant concentrations within the well screen, the pump intake should be located in the most contaminated interval.
      i. For example, at sites with LNAPLs, such as gasoline-type petroleum contamination, it may be appropriate to collect groundwater samples from the upper portion of the saturated screened interval. However, the pump intake and pumping rate must not allow drawdown of the water level to the level of the pump intake.
      ii. At sites with DNAPLs as sources of groundwater contamination, it may be appropriate to locate the pump intake in the lower portion of the well; however, the pump should not be placed in the lower two feet of the well if possible, so as to avoid disturbing sediment.
   d. For fractured bedrock sites and other sites with preferential contaminant flow pathways, the pump intake should be placed to sample the most hydraulically conductive interval, unless the sampling objective is to sample a different flow path.
5) Low-flow sampling is designed to achieve laminar groundwater flow through the well screen and into the pump intake. This sampling technique therefore requires knowledge of well construction and lithology surrounding the well, and it requires that the well be in good condition. Therefore if well construction information is unavailable, or screen silting/biofouling or other well construction issues have been observed, the well in question should not be used for low-flow sampling. Re-development of site wells is advisable prior to introducing low-flow sampling, particularly if wells are more than five years old.

6) Pump tubing must be appropriate for the analytes to be sampled. Certain types of plastic tubing can either sorb contaminants from sample water or contribute contaminants to sample water as it flows through the tubing.
    a. Teflon, Teflon-lined and steel tubing is preferred for sampling for organic compounds including VOCs, SVOCs, petroleum, pesticides and PCBs. If other tubing is used for these analytes, an equipment blank should be used to check that contaminants are not being added to the water, and SRS may require that a 'spiked' solution be run through the tubing to check for sorbtion.
    b. In addition to Teflon and Teflon-lined tubing, PVC, polypropylene or polyethylene tubing is also appropriate for metals sampling. Stainless steel tubing is not appropriate for collecting metals samples, although equipment blanks may demonstrate whether or not there is an effect.
    c. The smaller the diameter of tubing used, the easier it will be to maintain low flows without getting air bubbles in the tubing.
    d. Maximize tubing wall thickness and minimize tubing length to minimize diffusion between water and the atmosphere.
    e. If a peristaltic pump is used for low-flow sampling (see #2 above), pharmaceutical grade ("pharmed") tubing should be used around the rotor head of the pump to avoid diffusion to/from the atmosphere.
7) Pump rates for low-flow sampling should generally not exceed 0.3 liters/minute. Aquifers with particularly high conductivity may be able to sustain higher flow rates with laminar flow into the well and without excessive drawdown.
8) Initial depth to water must be measured prior to starting the water pump. Depth-to-water measurements must be collected frequently during purging and sampling and recorded in the sampling log; depth to water is typically measured at the same frequency as stabilization parameters are measured. Depth to water may be measured using an air-water interface probe, or a transducer located above the pump. If a transducer is used it must be 'truthed' at the start and end of sampling using an interface probe. Depth to water measurements should have minimum 0.01-foot accuracy. Care should be taken when inserting measurement devices into the well to avoid disturbance to the water column.
9) Total well depth should never be measured at the start of the low-flow sampling event, because this causes disturbance of the water column in the well. Instead, total well depth should be measured in advance of the sampling event, and may be re-measured after completion of a low-flow sampling event.
10) Initial drawdown should ideally not exceed 0.3 feet; however, initial drawdown in excess of 0.3 feet may be allowed if the water level stabilizes after that initial drawdown. If the water table is initially above the top of the well screen, then the water level should not be allowed to drop below the top of the well screen during purging and sampling. Also, total dewatering is never acceptable in low-flow sampling – if low-flow purging causes total dewatering, passive samplers may be an appropriate alternate sampling methodology.

11) Pumped water should flow through an in-line water quality meter such as a flow-through cell. Stabilization parameters should be decided on a site-specific basis, dependent on site geochemistry and other factors, with the following understanding:
    a. Field indicator parameters for stabilization include turbidity, dissolved oxygen, specific conductance, and redox potential. Temperature may also be recorded during well purging. Stabilization criteria should be those established in the EPA document ORD/OSWER EPA/540/S-95/504 as referenced at the end of this document.
    b. The key stabilization parameter for VOC sampling is dissolved oxygen, which should stabilize to three consecutive readings within 10% of each other (this is a 10% difference between the magnitudes of the readings, and not 10% DO in the samples), OR within 10% of 0.2 mg/L, whichever is greater. SRS may require that additional stabilization parameters be monitored.
    c. The key stabilization parameter for other contaminant sampling is turbidity, which should stabilize to three consecutive readings within 10% of each other, OR three consecutive readings below 10 Nephelometric Turbidity Units NTU, whichever is greater. SRS may require that additional stabilization parameters be monitored.
12) Stabilization parameters should be measured on a three- to five-minute frequency; where a flow-through cell is used, complete exchange of water through the flow-through cell is necessary between measurements. The proposed work plan/SAP/SOP for low-flow sampling must state the frequency of stabilization parameter measurements.
13) Samples should be collected after indicator parameters have stabilized. When more than one sample type is to be collected from the well, samples should be collected in order from most volatile to least volatile analytes.
    a. The pump should not be moved or turned off between purging and sampling.
    b. The pump rate may be decreased for sample collection in order to allow filling of sampling containers (this is often necessary to fill VOC sampling vials).
    c. Note – as in all groundwater sampling, make sure the flow-through cell is bypassed during sample collection.
14) If parameters do not stabilize, either:
    a. the well should be purged for a minimum of four hours prior to sampling, or
    b. a minimum of three well volumes should be evacuated from the well prior to sampling, or
    c. the sampler should discontinue purging and not collect a sample.

If a sample is collected, lack of stabilization of parameter values should be documented in the field logbook. Whether to allow sampling when parameter stabilization is unattainable is a site-specific and contaminant-specific decision.

Site-specific decisions:
Many decisions about protocol for low-flow sampling must be made on a site-specific basis. These include any proposed exceptions to the guidelines above, and the following additional requirements:

- QA/QC requirements
- Decontamination requirements – for portable pumps, dedicated pumps, dedicated tubing
- Condition of existing on-site wells and need for re-developing or replacing old wells
- Stabilization parameters and stabilization criteria
- Sample collection at wells where parameters do not stabilized after purging
- Field filtering requirements for any samples
- How to compare low-flow data to existing non-low-flow site data (VOCs may increase because of lower mixing, agitation, etc; metals, PAHs and other particulate-associated COCs may decrease due to less suspended sediment in the sample) – whether to require contemporaneous side-by-side sampling using low-flow and traditional methods to compare data, or whether to compare low-flow data to historical site data.

References:

Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures – Puls, R.W. and Barcelona, M.J. (April 1996) – EPA ORD/OSWER EPA/540/S-95/504

Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples From Monitoring Wells – EPA Region 1 (July 30, 1996) EPA R1 SOP# GW 0001.

Standard Operating Procedure for Low-Stress (Low Flow) / Minimal Drawdown Groundwater Sample Collection – EPA Region 9 (undated) EPA R9

Groundwater Sampling Procedure Low Stress (Low Flow) Purging and Sampling – EPA Region 2 (March 16, 1998) GW Sampling SOP Final.

Technical Guidance on Low-Flow Purging and Sampling and Minimum-Purge Sampling (2nd ed.) – Nielsen, D.M. and Nielsen, G.L. (April 2002) – Nielsen Environmental Field School, NEFS-TG001-02.

PTS-SOP-GW-10-LF

STANDARD OPERATING PROCEDURE
PURGING AND SAMPLING WITH A LOW FLOW SUBMERSIBLE PUMP

1. Using clean, non-contaminating equipment, e.g., an electronic level indicator (avoid indicating paste or chalk), determine the water level in the well.

2. Attach the appropriate disposable tubing to the pump outlet. (Note also that all down-hole and potentially wetted surfaces must also be non-contaminating/noncontributing. This includes power and suspension cables and compressed gas or sample tubing.)

3. Lower the pre-cleaned pump and tubing gently to approximately midsection of the saturated screened interval and begin pumping. Monitor draw down of the water table with an electrical level indicator, initial drawdown should ideally not exceed 0.3 feet; however, initial drawdown in excess of 0.3 feet may be allowed if the water level stabilizes after the initial drawdown.

4. Set the controls on the pump for the appropriate discharge rate, in general this would be between .25 and .5 liters a minute. Frequently measure the rate of discharge, a bucket or liter bottle and stopwatch are commonly used.

5. Collect or dispose of purged water in an acceptable manner.

6. Purge until discharge pH, conductivity, or temperatures have stabilized. Water quality parameters taken at approximately 3 to 5 minutes will be considered stable when three consecutive readings are as follows:

    - Temperature range is no more than +/- 1 degree Celsius (°C);
    - pH varies by no more than 0.2 pH units; and
    - Specific conductivity readings are within 10% of the average.

7. After field parameters have stabilized, fill necessary bottles by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled.

8. Select appropriate sample bottles and preserve the sample if necessary.

9. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

10. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Complete chain-of-custody documents and field logbook.

FIELD SAMPLE DATA SHEET

Page __ of __

Project Name: Old Landfill Groundwater Monitoring

WELL/STATION ______ ______ DATE ______ TIME ______

SAMPLERS ______ WEATHER CONDITIONS ______

PHOTO: Yes ______ No ______ ROLL# ______ NUMBER ______

PURGE DATA:

WELL DEPTH ______ Feet

PURGE METHOD ______ DEPTH TO WATER ______ Feet

START PURGING ______ COLUMN DEPTH ______ Feet

PURGE RATE ______ GPM CASING DIAMETER ______ Inch

RATE CHANGE 1) Time ______ Rate ______ PUMP SET AT ______ Feet

2) Time ______ Rate ______ 3 WELL VOLUMES ______ Gallons

SAMPLE TIME ______ TOTAL PURGE VOLUME ______ Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
	1 Liter		HNO_3	Dissolved Metals-
	1 Liter			
	1 Liter			
	1 Liter			
	1 Liter			

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: ______

______

APPENDIX B

PIONEER TECHNICAL SERVICES, INC.
GROUNDWATER MONITORING
STANDARD OPERATING PROCEDURES(SOPs)

PTS-SOP-DE-01

STANDARD OPERATING PROCEDURE
PERSONNEL DECONTAMINATION PROCEDURES

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection.

PROTECTION:

1. Follow personal protective measures outlined in the site-specific Health and Safety Plan.
2. In the event that personnel decontamination becomes necessary, the outer more heavily contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
3. Next, the inner, less contaminated items should be soap (nonphosphate)/tap water washed. Rinse the items in tap water.
4. Store the items separately so they are used in contaminated areas only.
5. For contaminants other than those found typically at uncontrolled hazardous waste sites, see the Health and Safety Officer.

EMERGENCY DECONTAMINATION:

1. If the decontamination procedure is essential to the life-saving process, decontamination must be performed immediately.
2. If heat related illness develops, protective clothing should be removed as soon as possible.

WASH, RINSE AND/OR CUT OFF PROTECTIVE CLOTHING/EQUIPMENT

3. If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. Wrap the victim to reduce contamination of others.
4. Alert medical personnel to the emergency and instruct them about potential contamination. Instruct medical personnel about specific decontamination procedures.
5. Dispose contaminated clothing and equipment properly.

PTS-SOP-DE-02

STANDARD OPERATING PROCEDURE
EQUIPMENT DECONTAMINATION

All equipment leaving the contaminated area of a site must be decontaminated. Decontamination methods include physical removal, chemical removal or a combination of both. Decontamination procedures, in some cases, are to be performed in the same level of protection used in the contaminated area of a site. However, decontamination personnel may be sufficiently protected by wearing one level lower protection. The following decontamination procedures are for typical uncontrolled hazardous waste sites. For a more specific or unusual contaminant such as dioxins, see the site-specific Health and Safety Plan. Decontamination procedures should be used in conjunction with methods to prevent contamination of sampling and monitoring equipment.

INORGANIC CONTAMINANTS - HEAVY METALS:

1. Remove gross contamination with a water rinse using pressurized or gravity flow tap water.

2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.

3. Rinse the equipment with tap water.

4. Rinse the equipment with distilled water.

5. Rinse the equipment with a mixture of 10:1 nitric acid in distilled water (10 parts water to 1 part nitric acid).

6. Rinse the equipment again with distilled water.

ORGANIC CONTAMINANTS:

1. Remove gross contamination physically with a disposable paper towel or with a water rinse using pressurized or gravity flow.

2. Wash equipment in a solution of soap (non-phosphate) and tap water with a stiff brush.

3. Rinse the equipment in tap water.

4. Rinse the equipment with deionized water.

5. Rinse the equipment with methanol.

EQUIPMENT USED FOR DECONTAMINATION:

1. Rinse equipment (brushes, buckets, tubs) used in the decontamination process with water, preferably pressurized.

2. Agitate the equipment used in the decontamination process in the soap/tap water solution. (The tub which holds the solution will only have the water rinse.)

3. Rinse equipment with tap water.

4. Place equipment in appropriate areas, so they are used only for decontamination purposes (label if necessary).

DISPOSAL OF DECONTAMINATION SOLUTIONS:

1. Proper disposal of the soap/tap water solution, the tap water rinse, and the deionized water rinse is to a proper waste water container.

2. Proper disposal of the solvent rinse is to a proper organic solvent waste container.

3. When contaminants have been identified, either in the solutions or elsewhere on the site, solutions should be disposed of appropriately. If they are hazardous (characteristic, listed, etc.) dispose of them as such.

4. WHEN USING OTHER THAN THE ABOVE MENTIONED SOLUTIONS, BE SURE TO CHECK WITH THE HEALTH AND SAFETY OFFICER AND THE PROJECT MANAGER. SOME SOLVENTS MUST BE EVAPORATED.

EFFECTIVENESS OF DECONTAMINATION:

1. Effectiveness of the decontamination procedures will be measured using field equipment rinsate blanks (see the site-specific Quality Assurance Project Plan).

PTS-SOP-DE-03

STANDARD OPERATING PROCEDURE
INVESTIGATION DERIVED WASTE HANDLING

During a Site Assessment (SA), Site Investigation (SI), or Remedial Investigation (RI) process investigation derived wastes may be generated. The following is the method for handling investigation-derived waste in accordance with EPA protocols and DEQ guidance:

1. Decontamination fluids will be collected and then disposed of by either sending to a TSD, evaporated, treated using an activated carbon or air sparging unit, or temporarily stored until determined if it is contaminated. Decontamination fluids generated from cleaning equipment used in background sampling or for sampling in areas where past results indicate that contaminants are below standards, will be disposed of to the ground surface.

2. Groundwater generated from developing and purging monitoring wells will be discharged to the ground surface if past monitoring results indicated that all contaminants were below groundwater standards. If past monitoring results indicated that one or more contaminants were above groundwater standards, the purged water and potentially contaminated water will be collected. If the water is determined to be below standards by laboratory analysis it will be discharged to the ground surface. There may be instances (i.e. inclimate weather) where purge water and/or decon water will be temporarily stored in drums or tanks to be treated on-site with granulated activated carbon or air sparging. If the water is determined by laboratory analysis to contain contaminants above groundwater standards and can not be treated on-site it, it will be stored on-site until shipping/disposal arrangements can be made. If the water is visibly contaminated it will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. All containers stored on-site will be labeled with the date, time, contents, any corresponding analytical data, collection location, contact person, contact agency, etc.

3. Soil and or cuttings from monitoring well installation will be placed back in the borehole unless it is visibly contaminated. If the soil is visibly contaminated the soil/cuttings will be drummed, labeled, and stored on-site until shipping/disposal arrangements are made. Soils from borings/well installations located in previously sampled areas that are known to be contaminated will be drummed, labeled, and left on-site until shipping/disposal arrangements are made.

4. Disposable equipment intended for one-time use and personal protective equipment (PPE) materials will be packaged for appropriate disposal. The disposable equipment and PPE utilized for sampling will be double bagged and disposed of as a solid waste in the local landfill. Disposable equipment and PPE utilized for sampling visibly contaminated sites or sites known to be contaminated from previous monitoring will

be packaged, drummed, labeled and left on-site until shipping/disposal arrangements are made.

5. Laboratories will dispose of the portions of the samples not used for analysis.

Personnel will decontaminate all equipment prior to sampling and before leaving the site, to prevent off-site contamination, in accordance with PTS-SOP-DE-02. Equipment decontamination will consist of a tap water rinse, soap and water wash, distilled water rinse, and air drying. If appropriate, additional rinses may be needed in association with decontamination procedures for specific contaminants (i.e., dilute nitric rinse for equipment used in sampling for metals, a methanol rinse for equipment used in sampling for certain organics).

All personnel must go through decontamination procedures whenever leaving a contaminated area. Decontamination procedures should be used in conjunction with methods to prevent contamination including minimizing contact with wastes and maximizing worker protection. Personnel must follow the Personnel Decontamination Procedure PTS-SOP-DE-01.

PTS-SOP-SA-01

STANDARD OPERATING PROCEDURE
SOIL AND WATER SAMPLE PACKAGING AND SHIPPING

1. WATER SAMPLE PRESERVATION precedes if the sample to be packed is water and preservation is required.

2. Each of the filled sample containers will be placed in separate ziplock bags to keep it clean, dry, isolated, and to protect the sample label. Samples will then be placed in a cooler which has been lined with a plastic bag. The samples will be surrounded with vermiculite to reduce movement and absorb any leakage. The garbage bag will then be tied to contain the vermiculite.

3. The Project Manager will double check the paper work (chain-of-custody form, etc.) to assure those samples recorded on the associated paper work are in the cooler. The Project Manager and the sampler will then sign the chain-of-custody form to relinquish custody.

4. The paper work will then be placed in a sealed ziplock bag and taped to the inside of the cooler lid.

5. The cooler will be labeled with the appropriate shipping labels (NOS, flammable liquids, flammable solids, this side up, fragile, etc.).

6. The cooler will then be closed and an address label will be affixed to the lid (a Federal Express label will also be affixed, if used, at this time).

7. The cooler will then be closed and chain-of-custody seals will be placed over the opening.

8. Tape will then be placed over the custody seals and around the cooler.

9. The cooler(s) will then be transported to a secure storage, to the shipping agent, or directly to the laboratory.

Note: Bagging of samples and lining of coolers will not be necessary if samplers transport samples directly to the laboratory.

PTS-SOP-SA-02

STANDARD OPERATING PROCEDURE
SAMPLE PRESERVATION AND CONTAINERIZATION FOR AQUEOUS SAMPLES

This SOP describes the techniques and quality control measures used to sample, prepare, and handle water containing the analytes listed below:

- Target Analyte List;
- Total Recoverable Metals;
- Cyanide;
- Sulfate;
- Nitrate/Nitrite;
- Chloride;
- Hardness;
- Pentachlorophenol;
- Dioxins/Furans; and
- Extractable Petroleum Hydrocarbons.

TARGET ANALYTE LIST:

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be acidified with dilute nitric acid (1 to 1) to a pH of 2 or less. Normally, 3 milliliters (ml) of dilute nitric acid per liter should be sufficient to preserve the samples. This will keep the metals in solution and minimize their absorption on the container wall.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within six months of collection. An exception is mercury (Hg) analysis, which must be completed in 28 days.

5. Serious errors may result during sampling and storage by failure to follow these guidelines.

TOTAL RECOVERABLE METALS

1. Follow the procedure outlined for the Target Analyte List.

CYANIDE

1. One liter polyethylene or glass bottles will be required from the contract laboratory.

2. Upon sample collection, the sample is to be preserved with dilute sodium hydroxide (NaOH) to a pH of greater than 12 or higher.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All samples should be analyzed within 12 days of collection.

SULFATE, CHLORIDE, HARDNESS

1. Because these four parameters can be analyzed together, one 1-Liter polyethylene or glass bottle will be required from the contract laboratory.

2. Upon sample collection and sample labeling and storing (as per PTS-SOP-SA-01), the sample should be stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

4. In the presence of organic matter, certain bacteria may reduce sulfate to sulfide. To avoid this, samples will be stored at or below 4°C.

NITRATE/NITRITE

1. A 250 ml polyethylene bottle is required for this analysis.

2. Upon sample collection, the sample should be acidified with sulfuric acid (H_2SO_4) to a pH of 2 or less and promptly stored at 4°C until analysis.

3. All samples must be analyzed within 28 days of collection.

PENTACHLOROPHENOL

1. A 2,360 ml amber glass jug is required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 °C until analysis.

3. All samples must be analyzed within 14 days of collection.

DIOXIN/FURANS

1. A 1,000 ml amber glass bottle will be required for this analysis.

2. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4 °C until analysis.

3. Samples must be extracted within 10 days of collection.

EXTRACTABLE PETROLEUM HYDROCARBONS (EPH)

1. Two 1,000 ml glass bottles are required for this analysis.
2. Upon sample collection, each bottle should be acidified with hydrochloric acid (HCL) to a pH of 2 or less and promptly stored at 4 ºC until analysis.
3. All samples must be analyzed within 14 days of collection.

PTS-SOP-SA-02b

STANDARD OPERATING PROCEDURE
SAMPLE PRESERVATION, AND CONTAINERIZATION FOR AQUEOUS SAMPLES

This SOP describes the techniques and quality control measures used to sample, prepare, and handle water containing the analytes listed below:

- Volatile Organic Compounds (VOC's);
- Semivolatile Organic Compounds (SVs);
- Pesticides/PCB's

VOLATILE ORGANIC COMPOUNDS:

1. Two 40-ml glass vials with a Teflon lined septum cap will be required from the contract laboratory.

2. Prior to sample collection, the sample is to be preserved by adding 1-ml of concentrated HCI to the vial. Alternatively, the vials may be supplies by the lab with the HCI preservative already in the vials. This will eliminate biological activity and the potential for biodegradation of the COCs.

3. Add sample water to the container slowly and with a minimum of aeration or disturbance, initially running down the side of the vial rather than dropping to the bottom. This is necessary to protect the integrity of the sample's volatile constituents. After the vial is filled, continue to add sample water until a meniscus is formed at the top, above the top of the vial. Hold the vial vertically and still for several seconds to allow any air bubbles to dissipate; gentle tapping of the vial may be required. Carefully place the cap on the mouth of the vial and screw the cap down.

4. Invert the vial and tap firmly to verify that no air bubbles are trapped in the container. If air bubbles are observed, discard the sample and resample using a new vial.

5. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

6. All VOC samples should be analyzed with in 14 days of collection.

SEMIVOLATILE ORGANIC COMPOUNDS

1. One three-liter brown glass bottle will be required from the contract laboratory.

2. Upon sample collection, the sample is to be preserved only by keeping the sample container at 4°C until shipped or delivered to the laboratory. This will keep biological activity to a minimum and the potential for biodegradation of COCs.

3. Label and store samples (as per PTS-SOP-SA-01); the samples should be stored at 4°C until analyzed.

4. All SV samples should be extracted with in 7 days of collection and analyzed with in 30 days after extraction.

PESTICIDES/PCBs:

1. Follow the same procedure as outline for the Semivolatile organic compounds.

PTS-SOP-SA-03

STANDARD OPERATING PROCEDURE
FIELD QUALITY CONTROL SAMPLES

Field quality control (QC) is a part of the Project Quality Assurance/Quality Control (QA/QC) program and is described in detail in the site-specific Quality Assurance Project Plan. This SOP describes the preparation and collection frequency of field QC blanks and duplicate samples from water media.

At least one set of field QC samples will be prepared for each sampling event. QA/QC samples will be collected at a frequency of 1:20. If the number of field QC samples taken is not equal to an integer multiple of the interval, then the next higher multiple will be used. For example, if a frequency of 1:20 is indicated and 28 samples are taken, then two QC samples will be prepared.

All field QC samples shall be shipped with field samples to the contract laboratory as per PTS-SOP-SA-01.

One field bottle blank will be required at 1:20 and as follows:

> A bottle blank is a sample bottle containing DS/DI water and preservatives and is prepared in the field. It is contained in a sample bottle randomly chosen from each lot of bottles received by the contract laboratory or supplier. A bottle blank is prepared by the same protocols as a normal sample, but is not exposed to any "field conditions" or sampling equipment. The appropriate sample number shall be placed on the bottle.

One field duplicate will be taken 1:20 and as follows:

> A field duplicate consists of two samples taken at the same location and time, but placed in different bottles for separate analysis. Each duplicate shall be analyzed for identical chemical parameters.

1. Collect an adequate volume of sample to accommodate two sample bottles.

2. Process the samples (as per SOPs) for each duplicate.

3. Label the two sample bottles with appropriate sample numbers.

4. Record duplicate number, sample number, and sample location in the field log book.

PTS-SOP-SA-04

STANDARD OPERATING PROCEDURE
CHAIN OF CUSTODY FORMS FOR ENVIRONMENTAL SAMPLES

This SOP establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of sample at the analytical laboratory. This procedure shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigations by Pioneer Technical Services, Inc. (Pioneer). It is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.

Chain of custody is an unbroken trail of accountability that ensures the physical security of samples, data and records. Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met if the samples are:

- in the responsible individual's physical possession;
- in the responsible individual's visual range after having taken possession;
- secured by the responsible individual so that no tampering can occur; or
- secured or locked by the responsible individual in an area in which access is restricted to authorized personnel.

RESPONSIBILITIES

PROJECT MANAGER:

1. The Project Manager is responsible for overall management of environmental sampling activities, designating sampling responsibilities to qualified personnel, and reviewing any changes to the sampling plan.

FIELD TEAM LEADER:

1. The Project Manager may act as the Field Team Leader or may choose to appoint a Field Team Leader.
2. The Field Team Leader is responsible for general supervision of field sampling activities and ensuring proper storage/transportation of samples from the field to the analytical laboratory. Chain of Custody forms will be reviewed for accuracy and completeness to preserve sample integrity from collection to receipt by an analytical lab. Review of Chain of Custody forms may be delegated to qualified personnel. The Field Team Leader is responsible for sample custody until the sample has been properly relinquished as documented on the chain of custody form.

FIELD SAMPLER

1. The Field Sampler is responsible for sample acquisition in compliance with technical procedures, initiating the Chain of Custody, and checking sample integrity and documentation prior to transfer.

2. Field samplers are also responsible for initial transfer of samples consisting of physical transfer of samples directly to the internal laboratory or transferred to a shipping carrier, (i.e., United Parcel Service or Federal Express) for delivery.

LABORATORY TECHNICIAN

1. The receiving Laboratory Technician is responsible for inspection of transferred samples to ensure proper labeling and satisfactory sample condition.
2. Unacceptable samples will be identified and segregated. The Environmental Manager will be notified.
3. The Laboratory Technician will review the Chain of Custody for completeness and file as part of the project's permanent record.

EQUIPMENT AND MATERIALS

- Seals and Labels;
- Chain of Custody forms (provided by contracted laboratory); and
- Packing and shipping materials as necessary.

1. All samples shall be collected and handled in accordance with PTS-SOP-SA-01 and PTS-SOP-SA-02, or other methods, if appropriate. Samples will be transported in insulated coolers with ice ('blue ice' is acceptable) as necessary to maintain temperature at 4° C+/- 2°C until receipt by the analytical laboratory.

2. The Field Team Leader or designated Field Sampler shall initiate the Chain of Custody form for the initial transfer of samples.

3. A Chain of Custody form will be completed and accompany every sample. The form includes the following information:

- Project code;
- Project name;
- Samplers signature;
- Sample identification;
- Date sampled;
- Time sampled;
- Analysis requested;
- Remarks;
- Relinquishing signature, data, and time; and
- Receiving signature, date, and time.

4. The Field Sampler relinquishing custody and the responsible individual accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form. (If the transporter is not an employee of Pioneer, the Field Sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature.)

5. One copy of the Chain of Custody form shall be filed as a temporary record of sample transfer by the Field Sampler. The original form shall accompany the samples and

shall be returned to Pioneer as part of the contracted laboratory Quality Assurance/Quality Control (QA/QC) requirements. The original form will be filed as part of the project's permanent records.

6. The Project Manager (or designee) shall track the Chain of Custody to ensure timely receipt of samples by an analytical laboratory.

PTS-SOP-SA-05

STANDARD OPERATING PROCEDURE
PROJECT DOCUMENTATION

This SOP establishes the requirements for documenting and maintaining field logbooks and photographs. These procedures shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigation by Pioneer Technical Services, Inc. (Pioneer). These procedures apply from the time field work begins until site activities are completed.

RESPONSIBILITIES

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written ink. The author will initial and date entries at the end of each day. All corrections will consist of a single line-out deletion in ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks shall include the following entries:

1. A description of the field task.
2. Time and date fieldwork started.
3. Location and description of the work areas, including sketches if possible, map references and photographs, and sketches of well construction details.
4. Names and titles of field personnel.
5. Name, address, and phone number of any field contacts or site visitors
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions.
7. Details of the fieldwork performed and field data sheets used with special attention to any deviation from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures.
8. All field measurements made.
9. Any field laboratory analytical results.
10. Personnel and equipment decontamination procedures.

For any field sampling work the following entries should be made:

1. Sample location and number.
2. Sample type and amount collected.
3. Date and time of sample collection.
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, and any other pertinent information.
5. Sampling method, particularly any deviations from the SOP.
6. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample.

7. Sample preservation, handling, packaging, labeling, and the laboratory where the samples will be sent.

Photographs will be taken of field activities using a camera-lens system or a digital camera system. Photographs should include a scale in the picture when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced.
2. A brief description of the subject and the fieldwork portrayed in the picture.
3. Sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives shall be placed in task files in the field office after the film is developed. Any supporting documentation from the bound field logbooks shall be photocopied and placed in the task files to accompany the particular slides or prints.

PTS-SOP-WFM-01

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH IN WATER

INSTRUMENT CALIBRATION:

Calibrate pH meter in the field at the beginning of each day of field work and when the standard check is out of calibration. Recheck calibration at end of day.

1. Rinse pH and temperature probes in deionized water.
2. Turn on meter and immerse pH and temperature probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize.
3. Rinse pH and temperature probe with deionized water.
4. Immerse pH and temperature probe in either a pH 4 or a pH 10 buffer solution depending on whether expected pH of samples is above or below pH 7. If expected sample pH is above pH 7, use pH 10 solution for the second calibration. If expected sample pH is below pH 7, use pH 4 for the second calibration. Calibrate meter to second pH solution allowing enough time for meter to stabilize.
5. Rinse pH and temperature probe with deionized water.
6. Recheck meter calibration to a pH 7 calibration solution. Repeat the calibration process (Steps 2-4) if value for final pH check is more than 0.1 units from pH 7.0.

FIELD PROCEDURES:

1. Rinse beaker with sample water three times.
2. Rinse pH and temperature probes with deionized water.
3. Fill beaker with sample water.
4. Turn on meter and immerse pH probe and temperature electrodes in sample water. Stir sample for thorough mixing. Read and record pH to nearest 0.01 unit once pH reading has stabilized.

5. Rinse electrodes with deionized water and store in carrying case.

Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnant water.

PTS-SOP-WFM-02

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF EH IN WATER

Redox-Potential (EH) measurements are performed using ORION model 96-78 redox electrode and ORION SA-210 or 250A portable meter set to the millivolt (mV) mode.

FILLING ELECTRODE:

The electrode shall be filled with one of the two solutions selected to best match the ionic strength of the sample solution to minimize junction potentials. The following solutions shall be used:

1. Dilute solution (total ionic strength less than 0.2 molar [M]). Use ORION dilute filling solution (Cat. No. 900001), which will match the potential of a conventional calomel electrode.

2. Concentrated solution (total ionic strength greater than 0.2M). Use ORION concentrated filling solution (Cat. No. 900011), which is 4M KCl saturated with Ag/AgCl.

Filling solution level in the electrode should always be at least one inch above the level of the solution being measured.

CONNECTING THE ELECTRODE TO THE METER:

Insert the platinum redox connector (large diameter) in the pH or sensing electrode input jack on the ORION SA-210 meter and the reference electrode connector (small diameter) into the reference electrode input jack.

CALIBRATION PROCEDURE:

The meter shall be calibrated daily using a two stage process that checks the operation and accuracy of the meter. To check the operation of the meter:

1. Connect the electrodes to the meter, place the electrodes in a beaker of tap water, and turn on the meter.

2. Add a drop of dilute NaOH to the beaker and mix it with tap water.

3. If the reading on the meter decreases sharply, then the electrodes are sensitive and operating properly.

4. If little or no change in the reading is observed, then the electrodes are not functioning properly and must be cleaned. The following summarizes the electrode cleaning procedures:

    - Drain filling solution from outer portion of electrode body and refill with fresh solution (see Filling Electrode).

    - If the electrode still does not function properly, remove sleeve from the inner electrode, rinse all the parts of the electrode with DS/DI water, and allow to air dry.

    - Reassemble electrode and refill with filling solution.

To check the accuracy of the meter and EH electrode:

5. Use a standard solution consisting of Zobell's ferrous/ferric solution.

6. Rinse electrodes with DS/DI water.

7. Pour the standard solution into a small beaker and place electrodes into the beaker. The redox potential of the standard solution should read 439 +/- 30 mV. If the reading deviates from this range, then the electrodes must be cleaned (see Step 4).

MEASUREMENT PROCEDURE:

1. Set the mode switch to the mV position, and place the electrode in the sample solution. When the reading stabilizes, record the potential.

2. For some applications, redox-potential readings are reported relative to the normal hydrogen electrode (NHE). To do this, select the electrode potential (C) value in Table FM-01-1 that corresponds to the filling solution used and the temperature of the solution measured. Substitute the table value for C in the following equation and solve for E.

    $E = Eo + C$ where:

    E - Oxidation reduction potential of the sample relative to the NHE.

    Eo - Potential developed by the platinum redox electrode.

    C - Potential developed by the reference electrode relative to the NHE (see Table WFM-02-1).

TABLE WFM-02-1

POTENTIALS ("C") DEVELOPED BY THE REFERENCE ELECTRODE PORTION RELATIVE TO THE NORMAL ELECTRODE AT VARIOUS TEMPERATURES

	"C" electrode Potential in mV	
Temperature °C	900001 Solution	900011 Solution
10	251	214
20	244	204
25	241	199
30	238	194

PTS-SOP-WFM-03

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

FIELD PROCEDURES:

1. Calibrate instrument as described in instruction manual. Usually the lowest concentration standard is appropriate. Recalibrate at the end of the day and note any drift. Replace batteries and try fresh calibration solutions if meter does not calibrate properly.
2. Rinse decontaminated beaker with sample water three times.
3. Fill beaker with water sample.
4. Rinse conductivity probe with deionized water and place probe in sample water.
5. Submerge conductivity probe in sample so that flow cell holes are immersed, stir to remove any air bubbles from within flow cell. Turn instrument on to appropriate scale for sample analysis. Read specific conductance and record to the nearest one Seimen (same as micromhos/centimeter). Measure sample temperature to the nearest 0.1 °C from conductivity meter after temperature has equilibrated.
6. Remove probe from sample and rinse with deionized water.
7. Correct conductivity reading to specific conductance (corrected to 25 °C) by multiplying the conductivity value by the temperature correction factor and then by the probe correction factor (unless SC unit has an automatic temperature correction).

MAINTENANCE:

1. Store meter in case during transport.
2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe.
3. Inspect probe for damage or dirt.
4. If meter readings are erratic, return meter and probe to factory for repair.

PTS-SOP-WFM-04

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

NOTE: Often, temperature is measured with a pH meter or the specific conductance meter. If included as part of those instruments, use SOP for that instrument. Otherwise:

1. Provide two calibrated thermometers inside protective cases for field measurements.

2. Check thermometer for cracks or gaps in the mercury. If cracks or gaps are visible, thermometer will not be used.

3. When possible, measure temperature of surface water at midstream, submersing the thermometer for approximately one minute or until temperature stabilizes.

4. When in situ temperature measurements are not possible, draw sample of at least 200 milliliters into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about one minute).

6. Record temperature to nearest 0.5°C in field log book or on field data sheet.

7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within 0.5°C.

PTS-SOP-WFM-07

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen meter for damage. Inspect probe for sufficient electrolyte and to determine if oxygen sensor membrane is in good condition. Replace membrane if torn or wrinkled. Inspect for air bubbles beneath the membrane. If bubbles are present, remove membrane and add electrolyte solution. Replace membrane so that air bubbles are absent.

2. Rinse probe and cable with deionized water.

3. Calibrate probe and meter according to manufacturer's instructions.

4. Place probe in water body to be sampled. Raise and lower probe through water sample at a rate of about one foot per second. Allow probe sufficient time to stabilize to temperature and dissolved oxygen concentration.

5. Read and record dissolved oxygen concentration.

PTS-SOP-GW-02

STANDARD OPERATING PROCEDURE
SAMPLING WITH A BAILER

1. If organic vapors are potentially present, remove the well cap and immediately screen headspace with the appropriate field monitoring instrument (e.g., PID or HNU). Refer to the HSP for detailed information of screening of well headspace if organic vapors are present.

2. Using clean, noncontaminating equipment, e.g., an electronic level indicator (avoid indicating paste), determine the water level in the well, then calculate the fluid volume in the casing. Also check for the presence of free or floating product with an interface probe or clear bailer (PTS-SOP-S-05).

3. Purge well by pumping or bailing until pH (PTS-SOP-WFM-01), specific conductance (PTS-SOP-WFM-03), and temperature (PTS-SOP-WFM-04) have stabilized. Purge water shall be disposed of in accordance with the site-specific SAP and PTS-SOP-DE-03).

3. Attach a bottom discharging bailer to clean rope for lowering and raising.

4. Lower bailer slowly until it contacts water surface.

5. Allow bailer to sink slowly and fill with a minimum of surface disturbance.

6. Slowly raise bailer to surface. Do not allow bailer line to contact the ground surface.

7. Use bottom discharge device to slowly discharge sample into appropriate containers, or pour slowly from top of bailer. The sample should be transferred directly from the bailer to appropriate sample containers with minimal agitation of water to prevent volatilization of organics. If free floating product is present, additional sample collection may be required (refer to site-specific SAP).

8. Repeat Steps 2 through 5 as needed to acquire sufficient volume.

9. Preserve the sample, if necessary.

10. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

11. Label the sample bottle with an appropriate tag. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.

12. Place the properly labeled sample bottle in an appropriate carrying container maintained at 4°C throughout the sampling and transportation period.

13. Bailer will be thoroughly decontaminated after each use according to SOP-DE-02.

PTS-SOP-GW-03

STANDARD OPERATING PROCEDURE
DEPTH TO WATER LEVEL MEASUREMENTS

Electrical Depth to Water Indicator

1) Arrive at site with proper equipment fully decontaminated and in working order.

2) Inspect well and casing for a marked measuring point. If no measuring point is marked locate the north side of the well and determine a new marking point, choose the point for ease of accurately reading the measuring tape.

3) Test that the water level indicator is on and working by pushing the test button on the indicator and checking the buzzer sound level and/or checking for the light.

4) Lower the sensor probe slowly into the well to minimized disturbance of water when it is encountered.

5) As the sensor is lowered down the well, the buzzer and/or flashing light will indicate contact with water. Be aware that sensor may indicate water prior to actual water level if the probe contacts condensation on the well casing.

6) Once the buzzer has sounded, align the marked probe cable with the designated marking point and gently raise and lower the probe until the exact mark on the probe cable when water is encountered is identified.

7) Record this information in the project logbook as the depth to water (DTW). In addition, record where the marking point was located (e.g. TOC (top of casing), TOPVC (top of PVC), IPVC (inner PVC) to help maintain continuity if subsequent DTW readings are needed from this well.

8) Reel in sensor probe.

9) Decontaminate all equipment prior to re-use.

Chalked Measuring Tape Depth to Water Measurements

1. Arrive at site with proper equipment, fully decontaminated and in working order.

2. Coat the lower three to five feet of tape with chalk and lower into well. Listen for weight to contact water and lower tape an additional 0.5 foot. Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.

3. Decontaminate all equipment before re-use.

PTS-SOP-GW-10

STANDARD OPERATING PROCEDURE
PURGING AND SAMPLING WITH A LOW FLOW SUBMERSIBLE PUMP

1. Using clean, non-contaminating equipment, e.g., an electronic level indicator (avoid indicating paste or chalk), determine the water level in the well.

2. Attach the appropriate disposable tubing to the pump outlet. (Note also that all down-hole and potentially wetted surfaces must also be non-contaminating/noncontributing. This includes power and suspension cables and compressed gas or sample tubing.)

3. Lower the pre-cleaned pump and tubing gently to just below the water level and begin pumping. The pump should be placed within the top 2 feet of water in this well. Monitor draw down of the water table with an electrical level indicator, and if necessary, lower the pump appropriately to keep a constant flow of water.

4. Set the controls on the pump for the appropriate discharge rate, in general this would be between .25 and .5 liters a minute. Frequently measure the rate of discharge, a bucket or liter bottle and stopwatch are commonly used.

5. Collect or dispose of purged water in an acceptable manner.

6. Purge until discharge pH, conductivity, or temperatures have stabilized. Water quality parameters will be considered stable when three consecutive readings are as follows :

   - Temperature range is no more than +/- 1 degree Celsius (°C);
   - pH varies by no more than 0.2 pH units; and
   - Specific conductivity readings are within 10% of the average.

7. After field parameters have stabilized, fill necessary bottles by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Cap each bottle as filled.

8. Select appropriate sample bottles and preserve the sample if necessary.

9. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.

10. Label the sample bottle with an appropriate tag. Be sure to complete the tag with all necessary information. Complete chain-of-custody documents and field logbook.

APPENDIX C

HEALTH AND SAFETY PLAN (HASP) FOR
OLD BUTTE-SILVER BOW MUNICIPAL LANDFILL SITE/
CLARK TAILINGS FACILITY

HEALTH AND SAFETY PLAN
FOR BUTTE-SILVER BOW
OLD LANDFILL GROUNDWATER MONITORING

Prepared for:

Butte-Silver Bow
Department of Public Works
126 W. Granite
Butte, Montana 59701

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Butte, Montana 59702

March 2009

APPROVAL PAGE

HEALTH AND SAFETY PLAN
FOR BUTTE-SILVER BOW
OLD LANDFILL GROUNDWATER MONITORING

Prepared for:

Butte-Silver Bow
Department of Public Works
126 W. Granite
Butte, Montana 59701

______________________________ ______________
Reviewed by: Shawn Bisch, Pioneer Project Manager Date

______________________________ ______________
Approved by: Gary Keeler, BSB County Landfill Manager Date

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Appendix A Hospital Information

1.0 INTRODUCTION

The purpose of this Health and Safety Plan (HASP) is to set forth the minimum acceptable requirements and procedures for all the groundwater sampling activities conducted at the Old Butte-Silver Bow Landfill/Clark Tailings (Old Landfill). All work practices and procedures are designed to minimize exposure to hazardous materials and to eliminate any possibility of physical injury to Pioneer Technical Services, Inc. (Pioneer) employees, Montana Department of Environmental Quality (DEQ) personnel, subcontractors, and the local communities. Work performed under this HASP will be in accordance with applicable State of Montana Regulations, Occupational Safety and Health Administration (OSHA) Regulations, U.S. Environmental Protection Agency (EPA), and any other applicable standards and/or regulations.

2.0 ASSIGNMENT OF RESPONSIBILITIES

The members associated with the field sampling are listed below with their titles and responsibilities.

- DEQ Project Officer –Martin Van Oort;
- Site Project Manager –Shawn Bisch;
- Health and Safety Officer –Tara Schleeman; and
- Field Team Members – Julie Flammang and Brad Hollamon.

Field Team Members conduct the field activities with the Site Project Manager and the Health and Safety Officer including sampling, monitoring, and decontamination procedures.

3.0 BACKGROUND

3.1 SITE DESCRIPTION

The Old Landfill is located approximately 1 mile southwest of the city of Butte and covers approximately 130 acres. The site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County. The Old Landfill is accessed by traveling west to Butte, Montana, on U.S. Interstate 90 (I-90) and exiting at exit ramp 126, and then turning south on Montana Street. After traveling approximately 0.65 miles on Montana Street, a turn is made to the southwest onto Beef Trail Road, which is followed for approximately 0.5 miles where a turn is made to the east into the Copper Mountain Sports and Recreation Complex, which overlies the Old Landfill. The Copper Mountain Sports and Recreation Complex is composed of baseball diamonds, a walking trail, football/soccer fields, a children's playground, sand volleyball courts, and a driving range.

3.2 SITE HISTORY

The Old Landfill opened in approximately 1968 and accepted municipal solid waste from Butte and its vicinity and was issued an operating license by the DEQ in 1978 (a permit was not required previously). The Old Landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). It is estimated that approximately 600,000 tons of refuse had been disposed of at the site (Pioneer, 1997). During November 1990, the DEQ conducted a Preliminary Assessment (PA) of the Landfill in accordance with the National Contingency Plan (NCP). The site did not score high enough to be included as a Superfund site. In July 1992, Butte-Silver Bow was notified by DEQ that a Groundwater Monitoring Plan and a Groundwater Sampling and Analysis Plan (SAP) were required at the Landfill. Wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Assessment monitoring results showed that groundwater protection standards (GWPS) were exceeded for certain volatile organic compounds (VOCs) and thallium. Groundwater monitoring has been conducted biannually since that time. Landfill capping and passive gas venting as a corrective measure was approved on March 21, 1997. Remedial construction began in 1997 and was completed in 1998.

The Clark Tailings consisted of a 60-acre impoundment with approximately 1,000,000 cubic yards (cy) of mill tailings (Hydrometrics, 1983) immediately adjacent to and partially mixed with the Landfill. The mixed nature of the wastes necessitated a combined Superfund and the Resource Conservation and Recovery Act (RCRA) response action be performed under RCRA jurisdiction.

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During its years of operation, the mill served primarily as a zinc and copper concentrator. The Clark Tailings were reclaimed in the mid-1980s as part of the "Clark Tailings Erosion Control Project," by the Anaconda Minerals Company; however, vegetation recovery was sparse in many areas and it was determined that additional reclamation was necessary. During reclamation of the Colorado Tailings in the Lower Area One Operable Unit in the Butte Silver-Bow Superfund Site, approximately 800,000 cy of tailings were placed in a repository constructed at the Clark Tailings.

The final RCRA repository cover for the Old Landfill was designed in 1997 and constructed in 1997 and 1998. The Copper Mountain Sports and Recreational Complex was included as part of the final design and today the reclaimed area has several irrigated baseball and football fields, a walking trail, a children's playground and sand volleyball courts.

4.0 PROJECT DESCRIPTION

The groundwater sampling is limited to the sampling of six wells, three groundwater monitoring wells currently located within the Old Landfill (BSB-A1, BSB-A5 and BSB-A6R), one monitoring well located on Butte-Silver Bow land just west of the Old Landfill (MBMG-2), a monitoring well located on the northwest corner of the Old Landfill and in the right-of-way of

Little Basin Creek Road (CLK-2), and one monitoring well located on private property east of the Old Landfill boundaries (CLK-1). Static water levels will be measured in each of these wells on a semi-annual basis, in approximately March and September to document depth-to-groundwater and groundwater flow direction. Additionally, groundwater samples will be collected from the six wells on a semi-annual basis.

5.0 HEALTH AND SAFETY

While conducting sampling, personnel may be exposed to both chemical and physical hazards. Chemical hazards include exposure to groundwater with elevated vinyl chloride, arsenic, antimony, cadmium, nickel, and zinc concentrations. Additional chemical hazards include sample preservation acids (nitric and hydrochloric acid). Physical hazards include temperature extremes. Other hazards that may be present on site include lightning, insects, and slips, trips and falls. The site hazards are discussed in the following sections.

5.1 CHEMICAL HAZARDS

The following subsections provide information on the chemical compounds found in the groundwater.

5.1.1 Vinyl Chloride

Vinyl chloride is a colorless, flammable gas at normal temperatures with a mild, sweet odor. It is a manufactured substance that is used to make polyvinyl chloride (PVC) and is used to make a variety of plastic products, including pipes, wire and cable coatings, and furniture upholstery. Vinyl chloride also results from the breakdown of other substances, such as trichloroethane, trichloroethylene, and tetrachlorothylene (ASTDR ToxFAQs).

Vinyl chloride can enter the body through inhalation of contaminated air, ingestion of contaminated food/water, or adsorption through skin/eye contact.

Skin contact with the chemical will cause numbness, redness, and blisters. Long-term exposure may cause nerve damage and immune reactions.

The Department of Health and Human Services (DHHS) has determined that vinyl chloride is a known human carcinogen. Vinyl chloride exposure can result in liver cancer in people.

The OSHA Permissible Exposure Limit (PEL) for vinyl chloride is 1 parts per million (ppm).

5.1.2 Antimony

Routes of entry for antimony include inhalation, ingestion, and skin absorption. Signs and symptoms of exposure include cough, vomiting, dry skin, abdominal pain, vomiting, and diarrhea. Short-term exposure effects include gastrointestinal irritation and short-term exposure to levels far above the Occupational Exposure Limit (OEL) could result in death. Long-term exposure to the skin may cause dermatitis, especially when exposed to fumes. This substance may have effects on the eye, respiratory tract and lungs, resulting in pneumoconiosis.

The OEL for antimony is a PEL and Threshold Limit Value (TLV) of 0.5 milligrams per square meter (mg/m^3).

5.1.3 Arsenic

Arsenic is a silver-gray or tin-white metal that is found in the earth's crust. Routes of entry include inhalation, ingestion, skin, and/or eye contact absorption. Symptoms of exposure include discoloration of the skin and appearance of small corns or warts, gastrointestinal disturbances, and respiratory irritation.

The OSHA PEL is a Time Weighted Average (TWA) of 0.010 mg/m^3.

5.1.4 Cadmium

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). All soils and rocks, including coal, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Routes of entry for cadmium are inhalation, skin absorption, skin or eye contact and ingestion. Signs and symptoms of exposure are gastronomic distress, vomiting, diarrhea, respiratory irritation, and hyperpigmentation of skin. Cadmium is a potential occupational carcinogen. Long-term exposure can cause lung damage and fragile bones.

The OSHA PEL is a TWA of 0.005 mg/m^3.

5.1.5 Nickel

Routes of exposure include inhalation, ingestion, and skin contact. The most common adverse health effect of nickel is an allergic reaction. People can become sensitive to nickel when jewelry or other things containing nickel are in direct contact with the skin. Once a person is sensitized to nickel, further contact with the metal will produce a reaction. Usually a skin rash develops at the site of contact. In some cases, dermatitis may develop at a site away from the site of contact. Some people who are sensitized have asthma attacks following exposure to nickel

People who are not sensitive to nickel must eat very large amounts of nickel to suffer adverse health effects. The most serious effects of nickel, such as cancer of the lung and nasal sinus, have occurred in people who have breathed dust containing nickel compounds while working in refineries or processing plants. Other lung effects including chronic bronchitis and reduced lung function have been observed in workers breathing nickel.

The OEL for nickel is PEL and TLV of 1 mg/m^3.

5.1.6 Zinc

Routes of entry for zinc include inhalation, ingestion, and skin contact. Signs and symptoms of exposure include metallic taste, metal fume fever, dry skin, abdominal pain, nausea, and vomiting.

Short-term exposure to zinc fumes may cause metal fume fever and the effects may be delayed. Long-term skin contact may cause dermatitis.

The OELs for this substance are an OSHA PEL of 15 mg/m^3 and an American Conference of Governmental Industrial Hygienist (ACGIH) TLV of 10 mg/m^3.

5.2 PHYSICAL HAZARDS

The physical hazards associated with this project include heat and cold stresses.

5.2.1 Cold Temperature Emergencies

Other physical hazards include temperature extremes. The potential for cold emergencies to personnel will be mild to significant based on the personal protective equipment (PPE) being worn, the ambient temperature, and the amount of activity. The health effects associated with cold stress are frostbite, trench foot, and general hypothermia.

Frostbite happens when the skin tissue actually freezes and cell damage results. Fingers, toes, cheeks, nose, and ears are commonly affected. The symptoms of frostbite include an uncomfortable sensation of coldness; there may be a tingling, stinging, or aching feeling followed by numbness. Initially the frostbitten area appears white and cold to the touch. This is followed by heat, redness, and swelling. Tissue damage can be mild or severe resulting in scarring and tissue death. First aid includes treating affected areas with warm water. Do not rub the affected areas.

Trench foot may be caused by continuous exposure to a wet and cold environment or immersion in water. Symptoms include a tingling and/or itching sensation, pain, and swelling. Blisters may form and be followed by death of skin tissue and ulceration. Treatment includes moving the victim to a warm area and treating the affected part with warm water or warm packs. Medical attention should be obtained as soon as possible.

General hypothermia is progressive loss of body heat with prolonged exposure to cold. Signs and symptoms of exposure include uncontrollable shivering and feeling cold. As the body temperature continues to drop, a person may become confused, careless, and disoriented. If the core body temperature falls below 86 degrees Fahrenheit (° F), the body's adaptive mechanisms for reducing heat loss become ineffective and death can occur. First aid includes moving the individual to a warm, dry shelter. All wet clothing should be removed and the individual should be wrapped in warm blankets. Warm, non-alcoholic, caffeine-free drinks may be given.

5.2.2 Warm Temperature Emergencies

Personnel need to be aware of the signs and symptoms of heat stress. Heat stress occurs when the body is unable to cool itself. Continued exposure to heat can cause heat cramps, heat exhaustion, and heat stroke.

Heat cramps are painful spasms of the muscles. They are caused when workers fail to replace their bodies' salt loss. Heat cramps may occur during or after work and may be relieved by taking liquids by mouth or saline solutions intravenously for quicker relief, if medically required.

Heat exhaustion results from loss of fluid through sweating when a worker has failed to drink enough fluids or take in enough salt, or both. The signs and symptoms of heat exhaustion include extreme weakness or fatigue, giddiness, nausea, headache, clammy and moist skin, pale or flushed complexion, and slightly higher body temperature. First aid includes resting in a cool place and drinking an electrolyte solution.

Heat stroke is the most serious form of heat stress. It is caused by the failure of the body's internal mechanism to regulate its core temperature. The body cannot cool itself and sweating stops. Signs and symptoms include mental confusion, delirium, and loss of consciousness, convulsions or coma, body temperature of 106 ° F or higher and dry hot skin. The victim must be moved to a cool area and his/her clothing soaked with cool water. Medical treatment is necessary.

5.3 OTHER HAZARDS

5.3.1 Lightning

Go to a safe shelter immediately. This includes a building or a hard top car with the window up. If in wooded area, seek shelter under thick growths of relatively small trees. Avoid isolated trees or other tall objects, bodies of water, sheds, fences, and heavy equipment.

5.3.2 Insect Bites/Stings

Symptoms may include redness, rash, swelling, chills, fever, diarrhea, and vomiting. Seek medical assistance. Wear protective outer clothing, such as long-sleeved shirts and gloves to prevent a bite or sting.

5.3.3 Slips, Trips, and Falls

Employees will be required to work on uneven terrain. Boots with traction will be worn. Always watch were you are stepping and be aware of the surroundings.

5.4 NEW OR ADDITIONAL HAZARDS

New and/or additional hazards will be discussed during the daily health and safety meeting. The hazards and appropriate control measures will be recorded in the logbook.

5.5 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

All personnel involved with the field operations will use Level D PPE, which includes coveralls and safety boots. Other Level D equipment may be used as appropriate, including: hardhat, gloves, or safety glasses. The PPE will be upgraded if conditions change.

5.6 INITIAL HEALTH AND SAFETY TRAINING

All personnel associated with sampling activities must have completed the 40-hour initial training per 29 Code of Federal Regulations (CFR), Part 1910.120 (e)(1) and the subsequent 8-hour annual refresher training, if applicable. At least one team member will have current American Red Cross community first aid and Cardiopulmonary Resuscitation (CPR) training. Proof of certification is required on-site.

5.7 VISITORS

Visitors must report to the Site Project Manager who will record the visitor in the field logbook. Visitors must demonstrate compliance with the training requirements to enter the exclusion zone (area of drilling and/or sampling). Visitors who are not exposed to sampling materials are not considered at risk; therefore, they are considered exempt from the above training requirements. Visitors will be allowed access to the exclusion zone areas if they demonstrate compliance with 29 CRF Part 1910.120 (e).

5.8 REVIEW OF HEALTH AND SAFETY PLAN

All personnel will review the HASP prior to the start of work and are expected to work in accordance with the HASP. The Site Project Manager/Safety Manager will be notified of any situation presenting a risk that has not been addressed in the plan.

5.9 HEALTH AND SAFETY MEETINGS

The Health and Safety meeting will be conducted each day, prior to starting work, to cover the suspected hazards expected for that day's work and the precautions necessary to deal with the hazards. If any unusual situation arises that might present an unsafe condition that was not discussed in the Health and Safety meeting, the Site Project Manager will stop work until an assessment of the problem has been made.

5.10 EMERGENCY PROCEDURES

In the case of an emergency, all workers will be evacuated from the site. The Health and Safety Officer is expected to notify the field team members of the closest hospital (Appendix A) and the appropriate route to the hospital (Appendix A – Figure 1). Emergency medical personnel, fire suppression, and law enforcement are available to the site by dialing 911 at the nearest phone (Pioneer personnel will have a cellular phone on-site).

5.11 PERSONAL/EQUIPMENT DECONTAMINATION

The following details decontamination of on-site personnel and equipment:

- All equipment will be decontaminated prior to use and prior to leaving the site. Decontamination consists of a tap water rinse, a soap and tap water wash, a distilled water rinse, and a methanol rinse.
- Decontamination fluids will be disposed to the ground surface leaving any site hazardous material on-site.
- Personnel will wash hands prior to drinking or eating.
- Eating and drinking areas will be separated from the sampling area and determined by the Health and Safety Officer.

5.12 GENERAL HEALTH AND SAFETY RULES

The following are general health and safety rules that will be enforced:

- A standard first aid kit will be present on-site at all times;
- Sampling will always take place with a minimum of two people on a team; and
- Sampling will only take place during the daylight hours.

6.0 REFERENCES

Agency for Toxic Substances and Disease Registry, ASTDR ToxFAQs, September 1997.

Hydrometrics, 1983. *Summit and Deer Lodge Valleys Long-Term Environmental Rehabilitation Study, Butte-Anaconda, Montana, Volume IV, Clark Tailings*, prepared for Anaconda Minerals Company, Butte, Montana. April, 1983.

Smith, R., 1953. *History of Early Reduction Plants of Butte, Montana*, reprint from De Re Metallica, Vol. 18, Nos. 2 and 3.

Pioneer, 1997. *Final Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measeures Assessment*. January 1997.

APPENDIX A

HOSPITAL INFORMATION

HOSPITAL INFORMATION
BSB Old Landfill Site

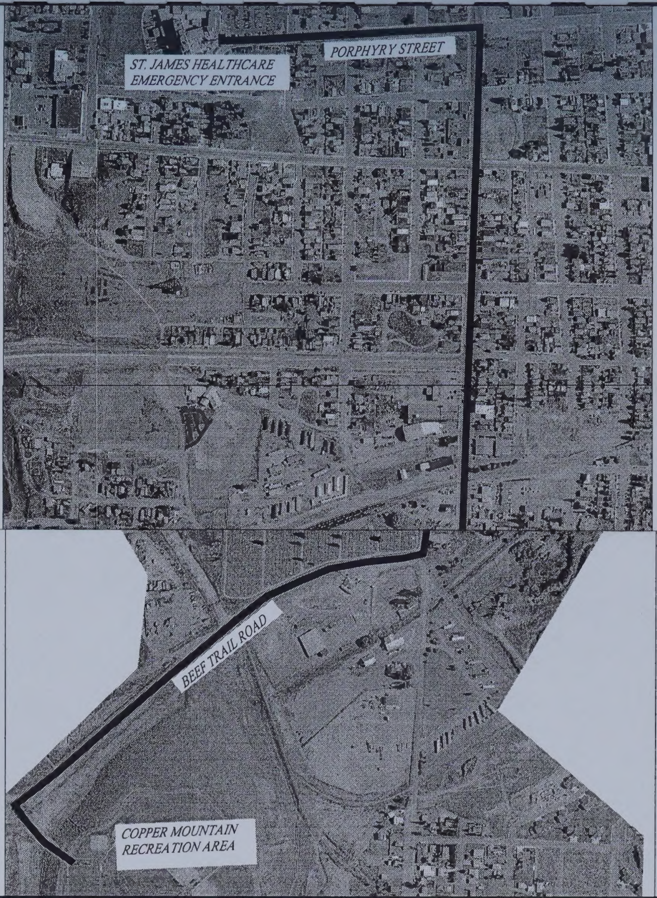
The nearest hospital location is: Butte, Montana (map on next page)

St. James Healthcare
400 S. Clark
Butte, Montana
(406) 723-2500

The ambulance, fire department, and sheriff can be reached by dialing 911.

Poison Control Center: 1-800-525-5042

Pioneer staff will carry a cellular phone with them on-site.


ST. JAMES HEALTHCARE
EMERGENCY ENTRANCE
PORPHYRY STREET
BEEF TRAIL ROAD
COPPER MOUNTAIN
RECREATION AREA

PROJECTION:
ZONE:
DATUM:
UNITS:
SOURCE:

SCALE IN FEET
0

FIGURE 1 EMERGENCY ROUTE
COPPER MNT TO ST JAMES

PIONEER
TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 3/10/2009

FILE PATH

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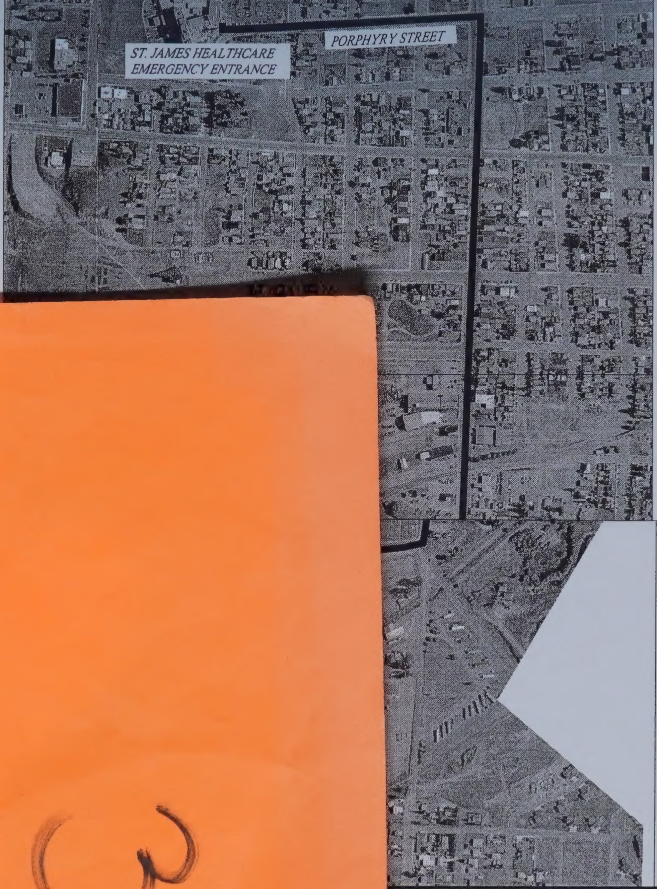
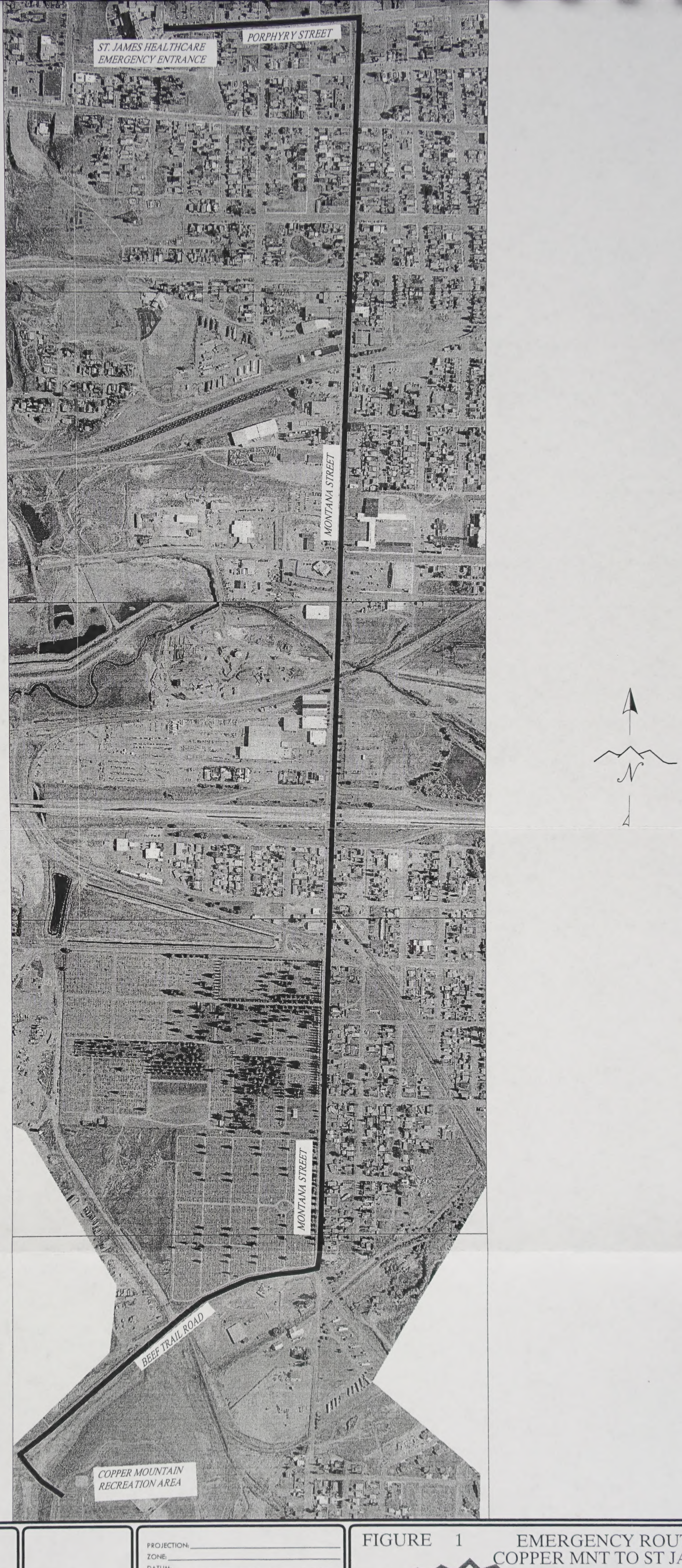

ST. JAMES HEALTHCARE
EMERGENCY ENTRANCE
PORPHYRY STREET

FIGURE 1 EMERGENCY ROUTE
COPPER MNT TO ST JAMES

PIONEER
TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 3/10/2009


ST. JAMES HEALTHCARE EMERGENCY ENTRANCE
PORPHYRY STREET
MONTANA STREET
MONTANA STREET
BEEF TRAIL ROAD
COPPER MOUNTAIN RECREATION AREA
N

PROJECTION: ____
ZONE: ____
DATUM: ____
UNITS: ____
SOURCE: ____

SCALE IN FEET
0

FIGURE 1 EMERGENCY ROUTE
COPPER MNT TO ST JAMES

PIONEER
TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 3/10/2009

APPENDIX D

MSE AND ENERGY LABORATORIES QA/QC PROGRAMS

MSE-111

QUALITY ASSURANCE PLAN FOR THE MSE ANALYTICAL LABORATORY

Prepared by:

MSE Analytical Laboratory
200 Technology Way
P.O. Box 4078
Butte, MT 59702
(406) 494-7334

October 2006

REVIEWS AND APPROVALS (MSE-111):

Prepared by: ______________________________
Laboratory Manager

Reviewed by: ______________________________
Quality Assurance Manager

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ACRONYMS

A	analytical spike
ASTM	American Society for Testing and Materials
BOD	biochem
CA	corrective action
Ca	calcium
CCB	continuing calibration blank
CCV	continuing calibration verification
CLP	Contract Laboratory Program
COC	chain of custody
COD	chemical oxygen demand
CRQL	contract required quantitation limit
CVAAS	cold vapor atomic absorption spectrophotometer
D	laboratory duplicate samples
DI	deionized water
DQO	data quality objectives
DTPA	diethylenetriaminepentaacetic acid
EPA	U.S. Environmental Protection Agency
GFAAS	graphite furnace atomic absorption spectrophotometers
HCl	hydrochloric acid
HDPE	high density polyethylene
Hg	mercury
HNO_3	nitric acid
ICP-AES	inductively coupled plasma - atomic emission spectrometer
ICP-MS	inductively coupled plasma - mass spectrometer
ICSA	Interference Check Solution A
ICSB	Interference Check Solution B
ICV	Instrument Calibration Verification
IPC	Instrument Performance Check
IDC	initial demonstration of capabilities
K	potassium
LAN	Local Area Network
LCS	laboratory control sample
L	serial dilution
LFB	laboratory fortified blank
LFM	laboratory fortified matrix
LIMS	laboratory information management system
LLCCV	low level CCV
LRB	laboratory reagent blank
MDL	method detection limit
Mg	magnesium
Na	sodium
NELAC	National Environmental Laboratory Accreditation Conference
NIST	National Institute of Standards and Technology
PB	prep blank
QA	quality assurance
QAP	quality assurance plan
QC	quality control
QCS	quality control sample

ACRONYMS (CONT'D)

R	laboratory replicate sample
RPD	relative percent difference SICS
SDG	Sample Delivery Group
SICS	Spectral Interference Check Standard
SOP	Standard Operating Procedure
SOW	Statement of Work
TC	total carbon
TDS	total dissolved solids
TOC	total organic solids
TS	total solids
TSS	total suspended solids
TVS	total volatile solids
VOC	volatile organic compounds
WAD	weak acid dissociable

1. QUALITY ASSURANCE PLAN OVERVIEW

1.1 POLICY AND OBJECTIVES

The general quality assurance (QA) policy of the MSE Analytical Laboratory (MSE Laboratory) is to generate all data with documented quality control (QC) through internal MSE Laboratory management policies to meet established method- and/or project-specific data quality objectives. The primary emphasis of the Quality Assurance Plan (QAP) is two-fold. The first is to define QC procedures for all activities that take place in the MSE Laboratory, which include receipt, handling, and storage of samples; preparation and maintenance of standards, reagents, and water; calibration and maintenance of analytical equipment; performance and evaluation of analytical methodologies; and the compilation and generation of reportable data. The second emphasis of the QAP is to characterize the documentation practices used in all facets of the MSE Laboratory process.

1.2 SCOPE

The purpose of this QAP is to specify general practices and procedures that ensure MSE Laboratory data are of a known and documented quality. While this QAP provides general direction for QA and QC and specifies certain MSE Laboratory procedures, it is not intended to be a detailed specification of QC criteria and standard operating procedures (SOPs) for all MSE Laboratory processes. Detailed specifications and SOPs are to be found in separate documentation for each type of analysis performed by the MSE Laboratory; an SOP directory is provided in Appendix A.

1.3 RECORDS

Additionally, this QAP and MSE Laboratory policy require that all activities associated with analytical procedures be clearly documented in an easily retrievable form. This is accomplished by using analysis-specific bench sheets, logbooks, spreadsheets, instrument run logs, and other documentation as required. All records must be recorded in indelible ink, free of whiteout or erasures, and each page must be initialed and dated by the person performing the work. All corrections to records must be made by drawing a single line through the incorrect entry, writing the correct information, and initialing and dating the correction. The purpose of the documentation is to ensure that all MSE Laboratory activities can be completely and accurately reconstructed after substantial time has passed without reliance on memory.

1.4 QUALITY SYSTEM COMPONENTS

Components of MSE Laboratory's quality system include:

- QAP;
- SOPs;
- workload scheduling;
- quality system audits;
- performance evaluations; and
- data validation.

1.5 PROCEDURES FOR REVISING THE QAP

This QAP will use MSE's document revision procedures as outlined in MSE's Facility Manual, Section 1.3.2.1.

1.6 MSE LABORATORY ORGANIZATION

An MSE Laboratory Organization Chart is shown in Figure 1-1.

1.7 PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

1.7.1 Laboratory Manager

The Laboratory Manager is responsible for overseeing the daily operations of the MSE Laboratory and its professional staff, with the goal of efficiently producing high-quality data within required timeframes. The Laboratory Manager also provides technical direction and business leadership.

The Laboratory Manager is the primary point-of-contact for customers and coordinates with the QA Officer to ensure that MSE Laboratory certifications are maintained and that necessary QA proficiency programs are accomplished.

The Laboratory Manager must have as a minimum a B.S. in a science or engineering field and 2 years of managerial experience in an environmental laboratory, or an equivalent combination of education and experience.

1.7.2 Quality Assurance Officer

The QA Officer is designated by the EPA/Analytical Programs Manager, and is responsible for auditing QA activities to ensure compliance with the QAP on an annual basis. The QA Officer reports to MSE's QA Manager. The QA Officer assists with development and implementation of SOPs for activities occurring within the MSE Laboratory and reviews and approves all QA activities associated with specific projects. The QA Officer periodically reviews data reports prior to their submittal to clients but has no data generation duties. The QA Officer also coordinates all QA activities undertaken by the MSE Laboratory staff, including data review functions performed by qualified MSE Laboratory staff (i.e., Laboratory Manager, Production Manager, and Chief Analytical Chemist).

The QA Officer must have as a minimum a B.S. in a science or engineering field and two years experience in quality assurance, or an equivalent combination of education and experience.

1.7.3 Health and Safety Office

The Health and Safety Office is responsible for ensuring that all MSE Laboratory activities are conducted in a safe manner in compliance with the MSE Chemical Hygiene Plan and MSE's Health and Safety Program Manual. The Health and Safety Office documents any violations and identifies appropriate corrective actions.

1.7.4 Environmental Office

The MSE Environmental Coordinator also is responsible for safely and legally disposing of any wastes generated in the MSE Laboratory and constantly focuses on waste minimization.

1.7.5 Technical Staff

The MSE Laboratory includes technical staff that report to the Laboratory Manager, Chief Analytical Chemist, and Production Manager. The technical staff are responsible for: peer review of primary analyst data; performing sample analysis in a timely manner; use of approved SOPs for all analytical work; and communication with the QA Officer regarding scientific and technical issues, such as deviation from SOPs.

1.7.5.1 Chief Analytical Chemist

The Chief Analytical Chemist is responsible for ensuring that all instruments are operating correctly and that all analysts maintain proficiency with instrumental analysis. The Chief Analytical Chemist also assists the Production Manager and Laboratory Manager with reviewing and reporting data.

1.7.5.2 Production Manager

The Production Manager is responsible for receiving samples, tracking the status of analyses, and production and revision of data reports. A production meeting is held weekly to set priorities for analysis. Ongoing communication ensures that samples are analyzed in a logical order so that customer requirements are routinely met.

1.7.5.3 Laboratory Personnel

Laboratory personnel are responsible for a particular operational area within the laboratory and are primarily responsible for completing sample analysis for that area in either a primary or secondary capacity. These operational areas include: metals, wet chemistry, soils analysis, sample preparation, and field sampling.

In each area these individuals are responsible for:

- identifying work to be accomplished based on communication with the Production Manager, setting short-term priorities, and reporting problems in the technical area;
- recommending remedies on processes or QC to the Laboratory Manager or QA Officer as appropriate;
- tracking and monitoring weekly workload projections and notifying Production Manager of problems or deviations from anticipated deadlines;
- reviewing data generated by analysts and technicians within the team;
- working with the QA Officer to develop and ensure that current SOPs are used for specific technical areas and identifying SOPs that need to be developed or modified;
- ensuring QC criteria are regularly maintained within the team; and
- performing analytical work as experts within their team.

Personnel often cross over functional areas and perform multiple roles in the laboratory as dictated by shifting workloads.

1.7.6 Functional Areas

1.7.6.1 Metals

Metals analysts are responsible for performing analysis of drinking water and solid/aqueous environmental samples for metals using a graphite furnace atomic absorption spectrophotometer (GFAAS), cold vapor atomic absorption spectrometer (CVAAS), inductively coupled plasma-atomic emission spectrometer (ICP-AES), and inductively coupled plasma-mass spectrometer (ICP-MS).

1.7.6.2 Wet Chemistry

Wet chemistry analysts are responsible for performing analysis of environmental and drinking water samples for physical and chemical analysis of non-metals using wet chemical methods and instrumental techniques.

1.7.6.3 Soils Analysis

Soils analysis analysts are responsible for preparing environmental samples for sample digestion as well as determination of physical parameters and limited instrumental analysis of soils for nonmetal parameters.

1.7.6.4 Sample Preparation

Sample preparation analysts are responsible for measuring various physical parameters and sample preparation (digestion) of drinking water and solid/aqueous environmental samples.

1.7.6.5 Field Sampling

Field sampling analysts are responsible for collecting, packing, and delivering samples for various clients according to the project-specific sampling plan. Team members are responsible for adhering to proper sampling protocol, safety, and chain-of-custody (COC) requirements.

1.8 LABORATORY ETHICS

The MSE Laboratory is committed to providing its clients with accurate and defensible data and meeting all client requirements for data quality and integrity. To achieve this commitment, and as a condition for employment, all employees agree to follow the MSE Laboratory's policy regarding ethics and data integrity characterized in the items below.

- All work performed shall be in accordance with appropriate work order agreements, specified methods, SOPs, contracts, etc.
- All data values reported (e.g., sample results), including analysis dates and time, represent actual values obtained and are not modified or manipulated in any manner that is not described in the reference method.
- Analysts performing technical methods shall not represent work that was performed by other individuals as their own.
- Client results shall be kept strictly confidential and released to a third party only upon written permission by the client.

Violation of these standards is grounds for disciplinary action that may include termination. Each MSE Laboratory employee is required to read and sign a Code of Ethics (Figure 1-2) at the time of their initial employment.

1.9 EMPLOYEE TRAINING

Effective employee training is critical to producing accurate, high-quality analytical data. Prior to performing any work in the MSE Laboratory, employees are required to complete mandatory MSE safety training and orientation. The MSE Laboratory requires an Initial Demonstration of Capabilities (IDC) before an employee can independently operate an instrument or perform a method with which he/she is not already familiar. The employee is monitored during the analysis for adherence to the applicable

SOP(s), and the generated analytical data is reviewed by a qualified supervisor to ensure that all QA criteria are satisfied and that analytical results are acceptable. This activity is documented in the employee's personnel file and on Form MSE-84, Training Record.

Training records of MSE Laboratory staff are maintained in the Personnel and Health and Safety Offices. It is the responsibility of each staff member to ensure that records of completed training are given to the Personnel Office or Health and Safety Office for filing.

1.10 STANDARD OPERATING PROCEDURES

SOPs are an integral part of consistent quality MSE Laboratory work. MSE Laboratory SOP001, "Guidelines for the Preparation and Management of SOPs," describes the process for writing new SOPs, as well as the review and revision procedures for current SOPs. The use of approved SOPs for all routine MSE Laboratory operations is mandatory. Current versions of all SOPs are maintained on the Local Area Network (LAN) and in hard copy in the QA Officer's office. As new versions of the SOPs are approved by the Lab Manager, the QA Officer notifies all affected personnel. All analysts have access to the SOPs applicable to their analytical duties. All MSE Laboratory personnel are responsible for destroying old versions of their SOPs. SOPs are required to be reviewed by responsible personnel in each functional area on an annual basis for the purpose of keeping them up to date. Changes to MSE Laboratory procedures in the interim must be documented in the appropriate SOP(s) as soon as possible. A single copy of discontinued SOPs is retained in the QA Officer's SOP archive file.

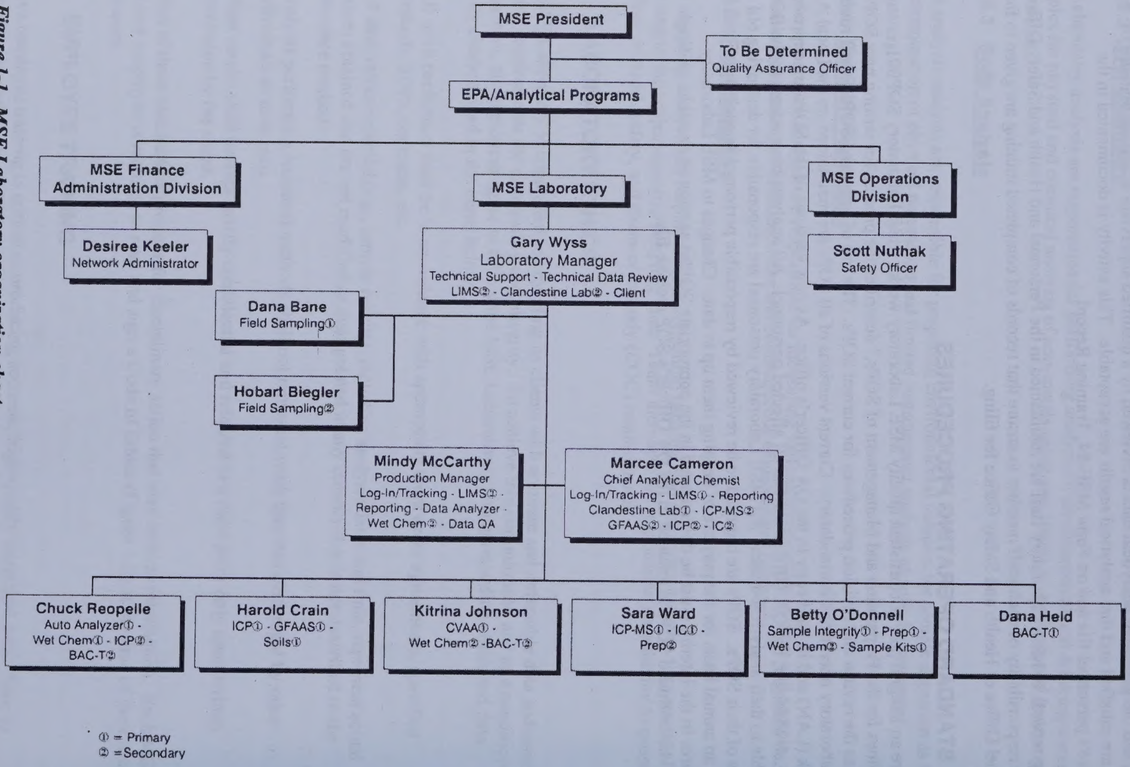

MSE President
To Be Determined
Quality Assurance Officer
EPA/Analytical Programs
MSE Finance Administration Division
MSE Laboratory
MSE Operations Division
Desiree Keeler
Network Administrator
Gary Wyss
Laboratory Manager
Technical Support - Technical Data Review
LIMS② - Clandestine Lab② - Client
Scott Nuthak
Safety Officer
Dana Bane
Field Sampling①
Hobart Biegler
Field Sampling②
Mindy McCarthy
Production Manager
Log-In/Tracking - LIMS② -
Reporting - Data Analyzer -
Wet Chem② - Data QA
Marcee Cameron
Chief Analytical Chemist
Log-In/Tracking - LIMS① - Reporting
Clandestine Lab① - ICP-MS②
GFAAS② - ICP② - IC②
Chuck Reopelle
Auto Analyzer① -
Wet Chem① - ICP② -
BAC-T②
Harold Crain
ICP① - GFAAS① -
Soils①
Kitrina Johnson
CVAA① -
Wet Chem② -BAC-T②
Sara Ward
ICP-MS① - IC① -
Prep②
Betty O'Donnell
Sample Integrity① - Prep① -
Wet Chem② - Sample Kits①
Dana Held
BAC-T①
① = Primary
② =Secondary

Figure 1-1. MSE Laboratory organization chart.

MSE ANALYTICAL LABORATORY

ETHICS AND DATA INTEGRITY AGREEMENT

I. I, __________________________, state that I understand the high standards of integrity required of me with regard to the duties I perform and the data I report in connection with my employment at the *MSE Laboratory.*

II. I have read the MSE Quality Assurance Plan and understand all aspects of the Plan that affect the work I will be performing at the MSE Laboratory.

III. I agree that in the performance of my duties at *MSE Laboratory:*

- a. I shall not intentionally report data values that are not the actual values obtained;
- b. I shall not intentionally report the dates and times of data analyses that are not the actual dates and times of data analyses; and
- c. I shall not intentionally represent another individual's work as my own.

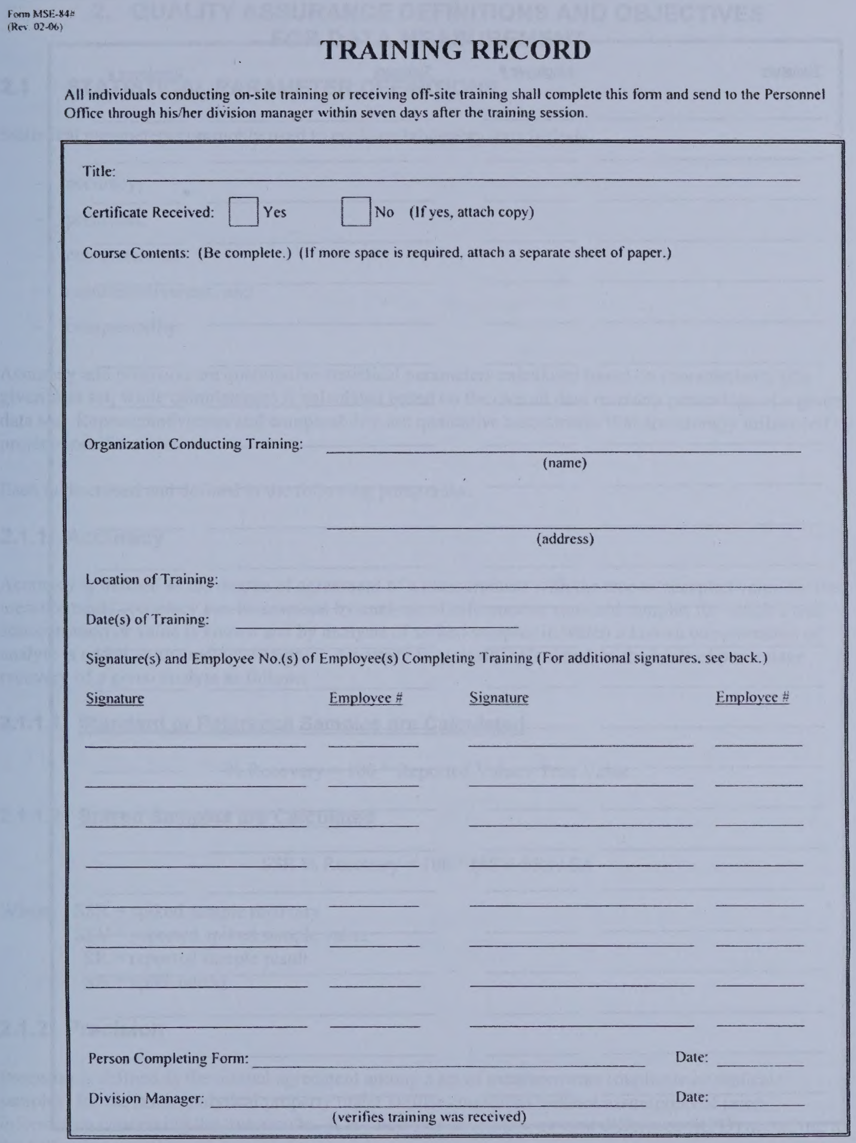
IV. I agree to inform *MSE Laboratory* of any accidental reporting of nonauthentic data by myself in a timely manner.

V. I agree to inform *MSE Laboratory* of any accidental or intentional reporting of nonauthentic data by other employees.

________________________________ *(Signature)*

________________________________ *(Date)*

Figure 1-2. MSE Laboratory ethics statement.



Form MSE-84#
(Rev. 02-06)

TRAINING RECORD

All individuals conducting on-site training or receiving off-site training shall complete this form and send to the Personnel Office through his/her division manager within seven days after the training session.

Title: ______________________________

Certificate Received: ☐ Yes ☐ No (If yes, attach copy)

Course Contents: (Be complete.) (If more space is required, attach a separate sheet of paper.)

Organization Conducting Training: ______________________________
(name)

____
(address)

Location of Training: ______________________________

Date(s) of Training: ____________________

Signature(s) and Employee No.(s) of Employee(s) Completing Training (For additional signatures, see back.)

Signature	Employee #	Signature	Employee #

Person Completing Form: ______________________________ Date: ________

Division Manager: ______________________________ Date: ________
(verifies training was received)

Figure 1-3. MSE Training Record.

Signature	Employee #	Signature	Employee #

Figure 1-3. MSE Training Record (Cont'd).

2. QUALITY ASSURANCE DEFINITIONS AND OBJECTIVES FOR DATA MEASUREMENT

2.1 STATISTICAL PARAMETER DEFINITIONS

Statistical parameters commonly used to evaluate laboratory data include:

- accuracy;
- precision;
- completeness;
- representativeness; and
- comparability.

Accuracy and precision are quantitative statistical parameters calculated based on characteristics of a given data set, while completeness is calculated based on the overall data recovery percentage of a given data set. Representativeness and comparability are qualitative assessments that are strongly influenced by project-specific objectives.

Each is discussed and defined in the following paragraphs.

2.1.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement with the true or accepted value for the measurement. Accuracy can be assessed by analysis of reference or standard samples for which a true concentration or value is known and by analysis of spiked samples in which a known concentration of analyte is added to an analytical sample. Accuracy is typically calculated on the basis of percentage recovery of a given analyte as follows.

2.1.1.1 Standard or Reference Samples are Calculated

$$\% \text{ Recovery} = 100 * \text{Reported Value} / \text{True Value}$$

2.1.1.2 Spiked Samples are Calculated

$$\text{SSR } \% \text{ Recovery} = 100 * (\text{SSV}-\text{SR}) / \text{SA}$$

Where: SSR = spiked sample recovery
SSV = reported spiked sample value
SR = reported sample result
SA = spike added

2.1.2 Precision

Precision is defined as the mutual agreement among a set of measurements (duplicate or replicate samples) for the same analytical property under similar conditions without assumption of prior information concerning the true results. It is calculated as relative percent difference (RPD) according to the following equation:

RPD % = 100 * 2 * absolute value (S-D) / (S+D)

Where: RPD = relative percent difference
S = first (original) sample value
D = duplicate or replicate sample value

2.1.3 Completeness

Completeness is defined as the measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under normal conditions and is expressed algebraically as:

Completeness % = 100 * NV/NT

Where: NV = number of valid measurements
NT = expected number of measurements

A valid result is a MSE Laboratory data point that meets the data quality objectives (DQO) of a given project.

2.1.4 Representativeness

This is a qualitative term that expresses the degree to which data accurately and precisely represents a characteristic of a population, variations at a sampling site location, a process condition, or an environmental condition.

Representative data has two important properties:

- it accurately represents a measured parameter, given the system sampled at a particular time and place; and
- there is complete certainty that the measurement can be ascribed to the particular sample rather than to another sample from a different location or time.

In the MSE Laboratory, the first property is ensured by specifying (in appropriate SOPs or other analysis specifications) the steps for preparing and analyzing each sample and confirming that the steps are followed. The second criterion is satisfied by using defined procedures for MSE Laboratory recordkeeping and data handling.

Similar procedures must be implemented by the field personnel to ensure collection of representative data when sampling is performed by MSE for laboratory clients. Sampling activities are typically under the auspices of project-specific or client-specific QAPPs.

2.1.5 Comparability

This is a qualitative term that expresses the confidence with which one data set can be compared to another. Comparability must be ensured in terms of consistency in sampling plans, analytical methods, QC, data reporting, etc., each of which may be project specific.

2.2 QA/QC SAMPLE DEFINITIONS

Numerous QA/QC samples are prepared by the MSE Laboratory to quantify the accuracy and precision characteristics of individual analytical data sets. Each QA/QC sample type is defined and discussed in Table 2-1. Additionally, unique, project-specific QA/QC samples not explicitly defined in this table are often prepared and analyzed to address specific client concerns.

2.3 QA/QC OBJECTIVES FOR THE MSE LABORATORY

Quality assurance/QC objectives for general chemistry (wet chemistry) analyses (i.e., inorganics other than metals) are discussed in Section 2.3.1. Quality assurance/QC for metals analyses is discussed in Section 2.3.2.

Additionally, the MSE Laboratory adheres to any special QA/QC requirements that may be specified by individual projects.

2.3.1 General Chemistry Parameters

Tables 2-2a and 2-2b summarize, for liquid and solid sample matrices respectively, the general chemistry parameters analyzed by the MSE Laboratory, including the reference analytical methods.

U.S. Environmental Protection Agency (EPA) methods (EPA, 1993) are used for most analyses not associated with drinking water. Some of these EPA methods are also used for drinking water analyses. However, certain types of drinking water analyses require the use of methods specified in Standard Methods for the Examination of Water and Wastewater (APAA, 1995) rather than the corresponding EPA methods. Such analyses are indicated in Table 2-2a by the presence of an entry in the column "Drinking Water Method."

Any modifications to these methods are addressed in the applicable SOPs. More detailed information on general chemistry QA/QC requirements are provided in Appendix B. Quality assurance/QC requirements specific to the ion chromatograph are shown in Appendix B, Table 2.

2.3.2 Metals Analyses

The MSE Laboratory analyzes samples for numerous metals using several instruments listed below.

- Inductively coupled plasma - atomic emission spectrometer (ICP-AES) for routine analyses of numerous metals, excluding mercury.
- Inductively coupled plasma - mass spectrometer (ICP-MS) for the routine analysis of trace metals.
- Graphite furnace atomic absorption spectrophotometers (GFAAS) for analysis of (typically) lower level concentrations of certain metals.
- Cold vapor atomic absorption spectrophotometer (CVAAS) for mercury analyses.

Each instrument has its own specific QA/QC requirements. Additionally, these requirements vary according to the regulatory auspices under which particular analyses are being performed, including:

- EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for Multi-Media, Multi-Concentration Inorganic Analysis (ILM05.3/ILMO6.X) (EPA, 2004 and EPA, 2005);
- EPA Drinking Water Methods (EPA, 1994; EPA, 1999; EPA, 2001a; and EPA, 2001b).

- EPA Office of Solid Waste SW846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA, 1983; EPA, 1986; EPA, 1990; EPA, 1991; EPA, 1997; and EPA, 2001).

Thus, for the combinations of the four instruments and three regulatory methods listed above, there are a total of 12 sets of QA/QC requirements, detailed in Appendices C, Tables 1 through 12. Table 2-3 provides a directory of these tables.

Many of the QA/QC criteria for a particular instrument vary depending on the analytical method, particularly for blanks.

2.3.2.1 EPA CLP

For the CLP methods, the blank performance requirements are stated as equal to the contract required quantitation limit (CRQL). In many cases, these CLP-specified blank limits are overly generous. Depending on the sensitivity of particular instruments for certain analytes, even blank results lower than the CRQL values will trigger investigative and/or corrective actions, based on the professional judgment of the Analyst, Chief Analytical Chemist, Laboratory Manager, and/or QA Officer.

2.3.2.2 EPA Drinking Water Methods

For analyses performed using EPA Drinking Water methods, blank limits are +/- 2 times the instrument method detection limit (MDL).

2.3.2.3 Modified SW-846 Methods

For analyses performed using modified SW-846 protocols, blank limits are +/- 3 times the instrument MDL (in the absence of project-specific requirements) with due consideration given to naturally occurring background concentrations.

In some cases, analyses performed using modified SW-846 protocols have fixed, client-specified analyte reporting limits.

2.3.4 Bacteriological Analyses

The MSE Laboratory performs bacteriological analyses for total and fecal coliforms according to the following methods (APHA, 1995).

- Standard Method 9222B: Membrane Filtration Method
- Standard Method 9221A: Multiple Tube Fermentation Method
- Standard Method 9223B: Presence/Absence Method

The associated QA/QC requirements are shown in Appendix D.

2.4 SAMPLE PRESERVATION AND HOLDING TIME REQUIREMENTS

In addition to satisfying the QA/QC requirements discussed in preceding sections, liquid samples must be properly preserved in the field at the time of sampling and analyzed within method and analyte-specific holding times to be considered valid. The "clock" for holding time calculation begins at the time the sample was collected, not at the time the sample arrives at the MSE Laboratory.

Table 2-4 shows the preservatives, holding times, and typical sample containers associated with analyses performed at the MSE Laboratory.

Table 2-1. QA/QC sample definitions.

Instrument Calibration Checks	Definition
Instrument Calibration Verification (ICV)	Certified sample standard or stock solution used to verify performance of instrument at known analyte concentration(s) immediately after initial calibration.
Continuing Calibration Verification (CCV) Instrument Performance Check (IPC)	Certified sample standard or stock solution used to verify performance of instrument at known analyte concentration(s) periodically during run.
Instrument Calibration Blank (ICB)	Deionized (DI) water blank containing same acid matrix as calibration standards used to verify performance of instrument immediately after ICV.
Continuing Calibration Blank (CCB)	DI water blank containing same acid matrix as calibration standards used to verify continuing performance of instrument immediately after CCV/IPC.
Interference Check Solution A (ICSA) Spectral Interference Check Standard (SICS)	Standard containing known concentrations of interfering analytes used to verify absence of elemental interferences.
Interference Check Solution AB (ICSAB)	Standard containing known concentrations of interfering analytes and analytes of interest used to verify absence of elemental interferences.
Contract Required Instrumental Standard (CRI)/Contract Required Analytical Standard (CRA)/CRQL Solution	Standard with concentration at CLP-required detection threshold.

Quality Control Samples		Definition
Digested QC Sample Type	Nondigested QC Sample Type	
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	Calibration Blank	Sample prepared for analysis using only preparation and/or digestion reagents. Results used to assess laboratory contamination.
Laboratory Control Sample (LCS)	Quality Control Sample (QCS)	A certified sample standard or stock solution is processed, digested, or extracted as appropriate and submitted to the analyst. Data is used to evaluate analytical accuracy.
Laboratory Duplicate Sample (D)	Laboratory Replicate Sample (R)	A second aliquot of an unknown sample is prepared and analyzed from the original. Data is used to evaluate analytical precision.
Laboratory Matrix Spike (LMS) Laboratory Fortified Sample Matrix (LFM)	Analytical Spike (A) Post-Digestion Spike	A spike of known concentration is added to an unknown. Spike is used to assess sample matrix interferences.
N/A	Serial Dilution (L)	Sample is diluted by a factor of 5 and rerun. Results compared to original sample result for indications of any sample matrix or interference issues.
Laboratory Fortified Blank (LFB)	Laboratory Fortified Blank (LFB)	Known quantities of method analytes are added to an LRB aliquot. Data is used to determine accuracy.

Table 2-2a. Methods for wet chemistry parameters (liquids).

Parameter	EPA Method	Drinking Water Method (required for drinking water analyses)
COLORIMETRIC		
Ammonia	EPA 350.2	
Chloride	EPA 325.2	
Chlorine	EPA 330.5	SM 4500-Cl G
Chromium +6		SM 7196A
Chemical oxygen demand (COD)	EPA 410.4	
Total Cyanide (TC)	EPA 335.2	SM 4500-CN E
Cyanide weak acid dissociable (WAD)	EPA 335.2	SM 4500-CN E
Iron Speciation		SM 3500-Fe D
Nitrate/Nitrite	EPA 353.2	
Nitrite	EPA 353.2	
Phosphorus – Ortho	EPA 365.3	SM 4500-P E
Phosphorus – Total	EPA 365.4	
Sulfate	EPA 375.2	
Total Kjeldahl Nitrogen	EPA 351.2	
Turbidity	EPA 180.1	
ELECTROCHEMICAL		
Conductivity	EPA 120.1	SM 2510B
Fluoride	EPA 340.2	SM 4500-F C
pH	EPA 150.1	
GRAVIMETRIC		
Sulfide - Acid Volatile	*	
Total Dissolved Solids (TDS)	EPA 160.1	SM 2540C
Total Suspended Solids (TSS)	EPA 160.2	
Total Volatile Solids (TVS)	EPA 160.4	
TITRIMETRIC		
Acidity	EPA 305.1	
Alkalinity	EPA 310.1	SM 2320B
Hardness	EPA 130.2	
Sulfide	EPA 376.2	
ION CHROMATOGRAPHY		
Bromide	EPA 300.0	
Chloride	EPA 300.0	
Fluoride	EPA 300.0	
Nitrate	EPA 300.0	
Nitrite	EPA 300.0	
Sulfate	EPA 300.0	

*Determination of Acid Volatile Sulfides and Simultaneously Extractable Metals in Sediment, EPA Research Laboratory, April 1991

Table 2-2b. Methods for general chemistry parameters (solids).

Parameter	Analysis Method
ACID-BASE ACCOUNTING	
Acid-Base Accounting	EPA-600/2-78/054 Method 3.2.6
Neutralization Potential	EPA-600/2-78/054 Method 3.2.6
Pyritic Sulfur (HNO_3 Extractable)	EPA-600/2-78/054 Method 3.2.6
Water Soluble Sulfur	EPA-600/2-78/054 Method 3.2.6
Sulfate (hydrochloric acid (HCl) Extractable)	EPA-600/2-78/054 Method 3.2.6
Total Sulfur	EPA-600/2-78/054 Method 3.2.6
Physical Parameters	
Bulk Density	USDA Agricultural Handbook #60
Percent Coarse Material	ASTM C29
Sand, Silt, Clay	Mod-ASTM D422
Soil Characterization	
Alkalinity	USDA Agricultural Handbook #60
Ammonia	Methods of Soil Analysis 33-7
carbon:nitrogen (C:N) Ratio	Methods of Soil Analysis 29-3.5.2 / 31-3
Calcium Carbonate Equivalent	USDA Agricultural Handbook #60
Electrical Conductivity	Methods of Soil Analysis 10-2.3.1 / 10-3.3
Kjeldahl Nitrogen	Methods of Soil Analysis 31-3
Lime Requirement (SMP Buffer)	Methods of Soil Analysis 12-3.4.4, 12-3.4.5
Loss on Ignition	Methods of Soil Analysis 1-4
Organic Matter	Methods of Soil Analysis 29-4.2
Percent Moisture	American Society for Testing and Materials (ASTM) 2216
Percent Saturation	Methods of Soil Analysis 10-2.3
pH (1:1 slurry)	Methods of Soil Analysis 12-2.6.5
pH (saturation extract)	Methods of Soil Analysis 10-2.3.1 / 10-3.2
Total Organic Carbon (TOC)/Matter	Methods of Soil Analysis 29-3.5.2(Walkeley Black)
Extractable Constituents	
Ammonium Acetate Extract.	Methods of Soil Analysis 9-3.1
Available Nitrogen	Methods of Soil Analysis 33-8.3
Available Phosphorus	Methods of Soil Analysis 24-5.4.1
Available Potassium	Methods of Soil Analysis 13-3.3.1
Cation Exchange Capacity	SW 846 Method 9081
Chloride (1:5 extraction)	Methods of Soil Analysis 10-3.5
diethylenetriaminepentaacetic acid (DTPA) Extraction	Methods of Soil Analysis 3-5.2
Saturation Extract	Methods of Soil Analysis 10-2.3.1
Sodium Absorption Ratio	EPA-600/2-78/054 Method 3.2.19
Soluble Salts (calcium, magnesium, sodium, potassium (Ca, Mg, Na, K)	Methods of Soil Analysis 10-3.4
Sulfate (1:5 extraction)	Methods of Soil Analysis 10-3.7
Total Metals Digestion	SW 846, various methods

Table 2-3. Summary of MSE Laboratory metals analysis methods.

Instrument / Model	Method	QA/QC Table
ICP-AES ARL 3560B	EPA 200.7 CLP-M	C-1
	EPA 200.7 (Drinking Water)	C-5
	Modified SW-846 6010C	C-9
ICP-MS Perkin Elmer Elan 6000 with Auto Sampler	EPA 200.8 CLP-M	C-4
	EPA 200.8 (Drinking Water)	C-8
	Modified SW-846 6020A	C-12
GFAAS Varian Spectra 400A with Auto Sampler, upgraded	EPA 200 Series CLP-M	C-2
	EPA 200 Series Drinking Water	C-6
	Modified SW-846 7010	C-10
CVAAS CETAC M6000A with Auto Sampler	EPA 245.1 CLP-M	C-3
	EPA 245.1 (Drinking Water)	C-7
	Modified SW-846 7470A/7471B	C-11

Table 2-4. Sample preservation and holding times.

Parameter	Preservative	Holding Time	Minimum Sample Size and Container
Metals			
Total Metals except Chromium^{+6}, Mercury	4 °C, pH<2 w/HNO_3	6 months	200-mL high-density polyethylene (HDPE) or glass
Total Chromium^{+6}	4 °C	24 hours	100-mL HDPE or glass
Total Hg	4 °C, pH<2 w/HNO_3	28 days	100-mL HDPE or glass
Hardness by Calculation (Ca and Mg)	Filter 0.45µ, 4 °C, pH<2 w/HNO_3	6 months	200-mL HDPE or glass
Dissolved Metals except Chromium^{+6}, Hg	Filter 0.45µ, 4 °C, pH<2 w/HNO_3	6 months	200-mL HDPE or glass
Dissolved Chromium^{+6}	Filter 0.45µ, 4 °C	24 hours	100-mL HDPE or glass
Dissolved Hg	Filter 0.45µ, 4 °C, pH<2 w/HNO_3	28 days	100-mL HDPE or glass
General Chemistry			
Acidity	4 °C	14 days	100-mL HDPE or glass
Alkalinity	4 °C	14 days	100-mL HDPE or glass
COD	4 °C, ph<2 w/H_2 SO_4	28 days	100-mL HDPE or glass
Chloride	4 °C	28 days	100-mL HDPE or glass
Chlorine, Residual	None	Analyze immediately	100-mL HDPE or glass
Chlorophyll (solid)	-10 °C – 30 mL methanol	24 hours	wrap in foil
Chlorophyll (water)	4 °C – filter and analyze immediately	24 hours	1 L amber
Conductivity	4 °C	28 days	100-mL HDPE or glass
Cyanide	4 °C, pH >12 w/NaOH	14 days	100-mL HDPE or glass
Fluoride	None	28 days	100-mL HDPE or glass
Hardness, Calc. (Ca and Mg)	4 °C	6 months	100-mL HDPE or glass
Hardness, Titration	4 °C	28 days	100-mL HDPE or glass
Nitrate	4 °C	48 hours	100-mL HDPE or glass
Nitrite	4 °C	48 hours	100-mL HDPE or glass
Nitrate and Nitrite	4 °C, pH <2 w/H_2SO_4	28 days	100-mL HDPE or glass
Nitrogen, Ammonia	4 °C, pH <2 w/H_2SO_4	28 days	100-mL HDPE or glass
Nitrogen, Kjeldahl	4 °C, pH <2 w/H_2SO_4	28 days	100-mL HDPE or glass
pH	4 °C	Analyze immediately	100-mL HDPE or glass
Phosphate, Ortho	Filter 0.45µ, 4 °C	48 hours	100-mL HDPE or glass
Phosphorus, Total	4 °C, pH <2 w/H_2SO_4	28 days	100-mL HDPE or glass
TDS	4 °C	7 days	200-mL HDPE or glass
TSS	4 °C	7 days	200-mL HDPE or glass
Solids, Total (TS)	4 °C	7 days	200-mL HDPE or glass
TVS	4 °C	7 days	
Sulfate	4 °C	28 days	100-mL HDPE or glass
Sulfide	4 °C, 2 mL zinc acetate, pH >9 w/NaOH	7 days	100-mL HDPE or glass
Turbidity (NTU)	4 °C	48 hours	100-mL HDPE or glass
Organics			
Trihalomethane	3 mg sodium thiosulfate	14 days	40-mL glass
Volatile Organic Compounds (VOC) – Chlorinated	25 mg ascorbic acid, pH<2 w/HCl	14 days	40-mL glass
VOC – Nonchlorinated	pH<2 w/HCl	14 days	40-mL glass
Bacteriological			
Biochemical Oxygen Demand (BOD)	None	48 hours	1 L
Coliform – Fecal	Sodium thiosulfate	30 hours	250 mL
Coliform - Total	Sodium thiosulfate	30 hours	125 mL

3. SAMPLE RECEIVING, DOCUMENTATION, AND REPORTING

3.1 OVERVIEW

The sample receiving, documentation, and reporting functions are managed by the MSE Laboratory's Production Manager. The objectives of these activities are to:

- ensure that samples are received at the laboratory in acceptable condition and notify clients if otherwise;
- assign a unique identifier to each sample container so that its progress through the MSE Laboratory can be tracked;
- schedule and assign sample analyses to appropriate MSE Laboratory personnel, ensuring that work is completed within client timeframes and that all samples are analyzed within required holding times; and
- ensure that samples are archived and/or disposed of as appropriate once analyses are completed.

3.2 SAMPLE RECEIVING

Incoming samples are delivered to the sample receiving area. Upon receipt, all shipping containers and security seals (when appropriate) are inspected for physical damage and evidence of tampering. When applicable, the samples are also are checked to verify that they were received at acceptable temperatures, typically 4 °C +/- 2 °C for water samples. Finally, the client's identification of each sample is verified against COC documents (discussed in detail in Section 4).

If any of the above or any other problems are noted, the client submitting the samples is notified immediately. Sample inspection is documented on the Sample Receipt Checklist (Figure 3-1).

Each sample is logged into a master logbook with columns for:

- laboratory sample number (see Section 3.3 for details);
- client work order;
- sample description;
- field identification number;
- collection date and time;
- analysis requested;
- date received;
- date reported;
- date of sample disposal or return to client; and
- the initials of the person logging in the sample.

This facilitates tracking of all samples from receipt by the MSE Laboratory through analysis and reporting and ending with disposal or return to client.

3.3 SAMPLE NUMBERING

All samples are assigned an MSE Laboratory number by the LIMS. The MSE Laboratory numbers follow the following format.

YYMMNNN-XXX(A-Z)

Where: YY = year
MM = month
NNN = sequential number designating the order in which the sample group is logged in during the year and month indicated by the first for digits, starting with 001
(A-Z) = single letter corresponding to each sample fraction submitted, for a group of analyses, for each location
XXX = sequential number assigned to individual samples.

The first seven digits of the laboratory sample number comprise the laboratory *work order*.

3.4 ASSIGNMENT OF SAMPLE ANALYSIS

After each sample is assigned an MSE Laboratory number, pertinent information is recorded in the Laboratory Information Management System (LIMS). The LIMS is a Microsoft Access-based database that is used to facilitate sample tracking and reporting.

After LIMS data entry, the MSE Laboratory number is placed on each sample container, and the samples are placed in a 4 °C ± 2 °C cooler in the secured storage area referred to as the Sample Bank. The Sample Bank is locked and/or monitored to prevent unauthorized entry, depending on the time of day. An important feature is the Sample Bank Logbook, which documents receipt and removal of all samples from the Sample Bank (Figure 3-2).

After delivery to the Sample Bank, the samples are ready for further preparation or analysis.

All additional documentation associated with the samples is initiated at this time, including:

- Work Order Summary Form (Figure 3-3), describing the types of analyses to be performed;
- any time-sensitive requirements (e.g., holding times or client deadlines);
- and the appropriate level of QC based on client specifications. The original is retained by the Sample Delivery Group (SDG) while a copy is given to each analyst involved in sample analysis;
- Computerized Laboratory Tracking Report. This report includes client and/or project name, sample description, work order number, requested analyses, and due dates, and is updated as needed; and
- separate project or client file for all related data.

3.5 SAMPLE PREPARATION

Many samples received by the MSE Laboratory require additional preparation prior to instrumental analysis, including addition of acids, extractions, etc. This work is performed by the Sample Preparation Technician based on the documentation supplied by the Production Manager. The Sample Preparation Technician removes the samples in question from the Sample Bank (documented in the Sample Bank Logbook), prepares the samples as required, then relinquishes the prepared samples and any unused sample portions back to the Sample Bank. Sample preparation data is entered into the LIMS and documented in the appropriate Sample Prep Logbook.

3.6 SAMPLE ANALYSIS

The appropriate analyst(s) removes prepared samples from the Sample Bank and performs the required analyses. After analysis, unused sample portions are returned to the Sample Bank, and all analysis records are given to the SDG for processing and reporting.

3.7 DATA REPORTING

After reviewing the data, the analyst or technician enters it into the LIMS. After additional QA review, the Production Manager or designee prints a draft data report. The required format and contents of data reports are generally client-specified at the time of initial sample delivery.

The Laboratory Manager, QA Officer, or their designee reviews the draft data report, makes corrections, requests reanalyses as necessary, and authorizes (in writing) release of the final report to the client.

The bacteriological analyses have their own specific data reporting requirements, which are detailed in Bacterial Procedures used for Examination of Potable Water Supplies (MSE, 2004a).

3.8 DATA ARCHIVAL

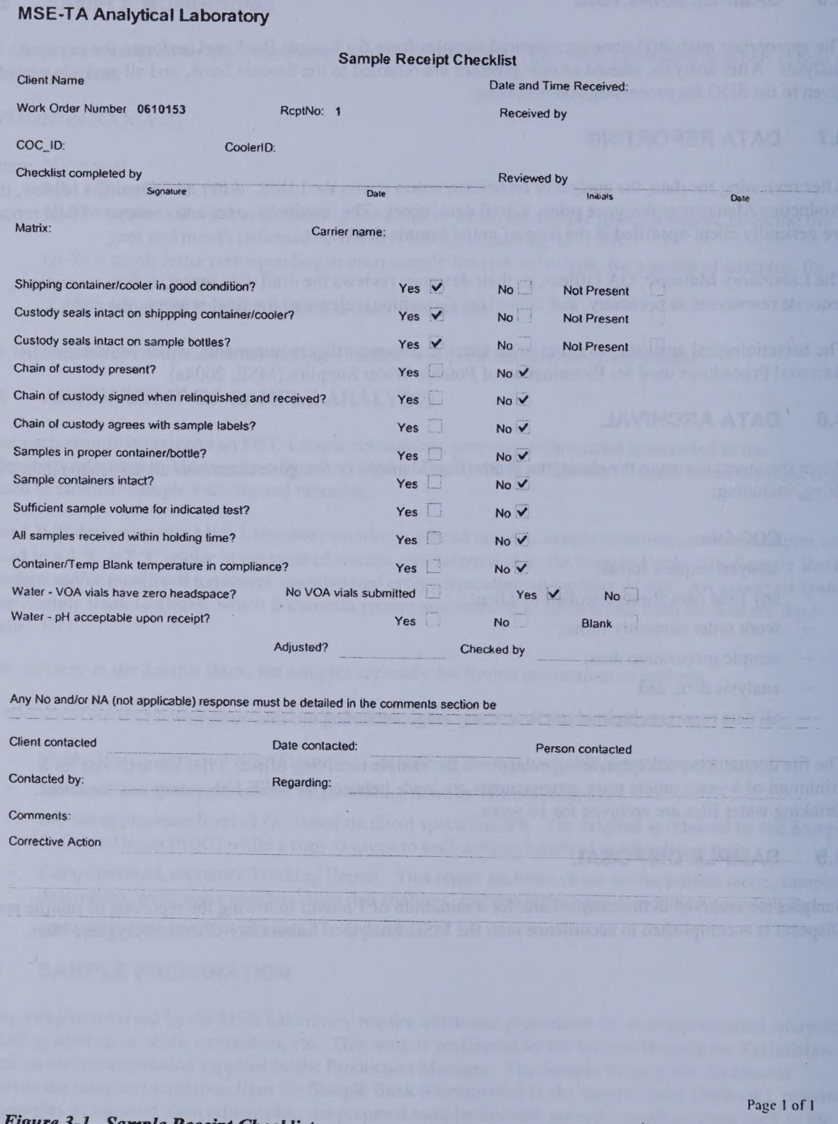
When the report is sent to the client, the Production Manager or designee assembles all associated data for filing, including:

- COC forms;
- analysis request forms;
- any field data sheets supplied by client;
- work order summary forms;
- sample preparation data;
- analysis data; and
- all data reports submitted to client at any stage, including the final report.

The file documents are kept in filing cabinets in the sample receiving office. Files are archived for a minimum of 5 years unless prior arrangements are made between the MSE Laboratory and the client. Drinking water files are archived for 10 years.

3.9 SAMPLE DISPOSAL

Samples are archived in the sample bank for a minimum of 1 month following the reporting of sample results. Disposal is accomplished in accordance with the MSE Analytical Laboratory Chemical Hygiene Plan.



MSE-TA Analytical Laboratory

Sample Receipt Checklist

Client Name
Date and Time Received:

Work Order Number **0610153**
RcptNo: **1**
Received by

COC_ID:
CoolerID:

Checklist completed by
Signature
Date
Reviewed by
Initials
Date

Matrix:
Carrier name:

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☑	No ☐	Not Present ☐
Chain of custody present?	Yes ☐	No ☑	
Chain of custody signed when relinquished and received?	Yes ☐	No ☑	
Chain of custody agrees with sample labels?	Yes ☐	No ☑	
Samples in proper container/bottle?	Yes ☐	No ☑	
Sample containers intact?	Yes ☐	No ☑	
Sufficient sample volume for indicated test?	Yes ☐	No ☑	
All samples received within holding time?	Yes ☐	No ☑	
Container/Temp Blank temperature in compliance?	Yes ☐	No ☑	
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☑	No ☐
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Blank

Adjusted?
Checked by

Any No and/or NA (not applicable) response must be detailed in the comments section be

Client contacted
Date contacted:
Person contacted

Contacted by:
Regarding:

Comments:

Corrective Action

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Figure 3-1. Sample Receipt Checklist.

BIF #	Laboratory Numbers	Client Name	Analysis/ Extraction/ Batch #	Log In		Log Out	
				Date/Initial	Date/Initial	Date/Initial	Date/Initial

Figure 3-2. Sample Bank Logbook.

WorkOrder 0609054

ERA WS122

20-Oct-06 3:00 pm

COMMENTS: HAROLD/KITRINA/CHUCK/SARA ****DUE 10/16/06****

WORKORDER/SAMPLE	Collected	Type	Customer/Client Sample ID
0609054-001A	9/5/2006	Aqueous	MSE Analytical Laboratory WS122-C/N 591
0609054-002A	9/5/2006	Aqueous	MSE Analytical Laboratory WS122 C/N 555
0609054-003A	9/5/2006	Aqueous	MSE Analytical Laboratory WS122 C/N 590

0609054-001A: Residue, Dissolved

0609054-002A: Calcium, Hardness (As CaC, Magnesium, Sodium

0609054-003A: Beryllium, Beryllium, Selenium, Iron, Molybdenum

	Date/Time	Location		Date/Time	Location
Sample Relinquished by:			**Received By:**		
Prep Relinquished by:			**Prep Received by:**		
Relinquished by:			**Received By:**		
Relinquished by:			**Received By:**		
Logged By:			**Reviewed:**		

MSE Analytical Laboratory

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Figure 3-3. Work Order.

4. COC PROCEDURES

4.1 OVERVIEW

The generation of traceable, defensible data requires strict observance of COC procedures, both in the field during sample collection and in the MSE Laboratory. The objective of COC documentation is to provide an historical record of the location and possession of a sample from the time of collection until disposal. Additionally, the COC provides a record of the analyses requested by the client.

4.2 COC FORM

The COC form used by the MSE Laboratory is shown in Figure 4-1. It is also common practice for clients to provide their own COC forms; this is acceptable provided they include the necessary information. The form is initiated at the time the client transfers custody of the associated samples to the MSE Laboratory.

The MSE Laboratory staff member who accepts the incoming sample shipment signs and dates the COC record to acknowledge receipt of the samples. Once this initial sample transfer process is complete, the MSE Laboratory maintains custody traceability with the COC form and other internal documentation.

4.3 TRANSFER OF SAMPLES WITHIN THE MSE LABORATORY

As discussed in Section 3.4, samples are placed in the secured sample bank once initial inspection and confirmation has been accomplished. After this point, transfers of samples to and from the sample bank (e.g., for preparation, analysis, disposal) are documented in the Sample Bank Logbook. This book documents the dates and times at which samples were retrieved from and delivered to the sample bank, by whom, and for what purpose.

4.4 TRANSFER OF SAMPLES OUTSIDE THE MSE LABORATORY

Occasionally, it is necessary to send samples outside the MSE Laboratory (e.g., when another laboratory is contracted to perform certain specialized analyses). Prior to transfer of samples, sample receiving procedures outlined in Section 3.2 are followed (i.e., sample inspection and log in). Next, samples are packed in appropriate shipping containers, including a COC form transferring custody to the party accepting shipment. Shipping containers are secured by placing custody seals across potential openings so that any tampering during transit is evident. A copy of the COC form is retained for the MSE Laboratory's records.

4.5 DISCREPANCIES IN COC RECORDS

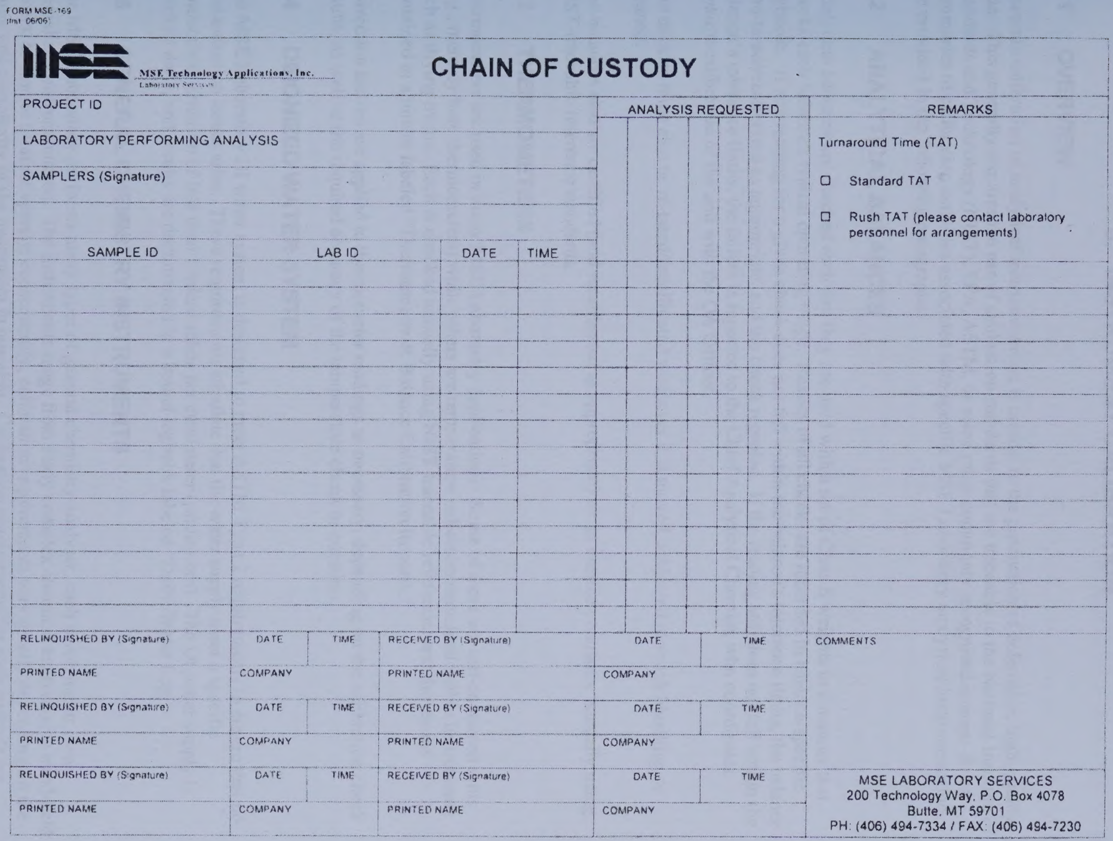
It is critical that any discrepancies involving COC records be noted and resolved as soon as possible before the beginning of any analytical activities. This is accomplished by comparing the samples received against the listings on the COC form immediately upon sample arrival and notifying the submitter of any deviations. If the problem cannot be resolved among the individuals involved, the Laboratory Manager or QA Officer will be contacted. The involved parties then develop a mutually acceptable course of resolution.

The same approach applies to discrepancies concerning transfers of samples within the MSE Laboratory, the difference being that these transfers are documented within the Sample Bank Logbook.

4.6 DISPUTE RESOLUTION

During the normal course of business, clients may make inquiries or complaints either verbally or in writing. No complaint or inquiry will be taken lightly or dismissed without due consideration. The MSE Laboratory will respond to all inquiries or complaints within an appropriate timeframe. All inquiries or complaints should be resolved at the lowest management level possible. If unable to resolve complaints through discussion and negotiation, the following dispute resolution procedure shall be followed:

- the Laboratory Manager is notified of the details of the complaint/dispute either verbally or in writing, including a definition of the complaint as well as supporting arguments for both the MSE Laboratory and the client; and
- within 10 business days, the dispute will be resolved by reprepping or reanalyzing samples as necessary or invoice adjustment as appropriate.



FORM MSE-169
(Int 06/06)

MSE Technology Applications, Inc.
Laboratory Services

CHAIN OF CUSTODY

PROJECT ID

LABORATORY PERFORMING ANALYSIS

SAMPLERS (Signature)

SAMPLE ID	LAB ID	DATE	TIME	ANALYSIS REQUESTED							REMARKS
											Turnaround Time (TAT) ☐ Standard TAT ☐ Rush TAT (please contact laboratory personnel for arrangements)

RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)	DATE	TIME	COMMENTS
PRINTED NAME	COMPANY		PRINTED NAME	COMPANY		
RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)	DATE	TIME	
PRINTED NAME	COMPANY		PRINTED NAME	COMPANY		
RELINQUISHED BY (Signature)	DATE	TIME	RECEIVED BY (Signature)	DATE	TIME	MSE LABORATORY SERVICES 200 Technology Way, P.O. Box 4078 Butte, MT 59701 PH: (406) 494-7334 / FAX: (406) 494-7230
PRINTED NAME	COMPANY		PRINTED NAME	COMPANY		

Figure 4-1. Chain-of-custody form.

5. INSTRUMENT CALIBRATION

5.1 OVERVIEW

Accurate calibration of analytical instrumentation is critical to the production of defensible, high-quality data. This generally requires the use of calibration standards that are traceable to the National Institute of Standards and Technology (NIST), EPA, ASTM, or some other commonly recognized source. Brief summaries of calibration activities associated with specific MSE Laboratory analytical instrumentation are provided in the following paragraphs.

5.2 ANALYTICAL BALANCES

Analytical balances are checked each day they are used with a set of Class S weights in a manner that checks each balance's typical operating range. Results of all checks are recorded in balance-specific logbooks. If any reading for a given check does not fall within the balance's tolerance limits, the balance is re-tared/recalibrated as appropriate, and the check repeated. If the reading still does not fall within the balance's tolerance limits, the failure is reported to the Chief Analytical Chemist, who coordinates repair/recalibration of the unit with the QA Officer.

The balance must also be re-tared/recalibrated whenever it is moved, subjected to rough handling, or cleaned.

The balances also are certified (and recalibrated as appropriate) by an outside contractor annually using NIST-traceable reference standards.

5.3 THERMOMETERS

Thermometers are used in many MSE Laboratory applications. Some of these are self-contained units (e.g., mercury bulb thermometers) while others are temperature indicators contained within instruments such as drying ovens. Each is checked annually using NIST-traceable references and the results contained in a binder labeled "Thermometer & Balance Calibration Reports."

Correction factors are applied to thermometer readings as necessary, depending on the calibration check results, as well as the required accuracy of the temperature check in question.

5.4 DEIONIZED WATER SYSTEM

The MSE Laboratory DI water system is designed to meet ASTM Type 2 requirements to ensure that no contamination issues arise. These requirements stipulate that the water supply meet a specific conductivity criterion of less than 1 micro-mhos per centimeter (µmhos/cm). The DI water supply is checked daily, and results are documented in a bound logbook labeled "Daily Water Log."

5.5 GENERAL CHEMISTRY INSTRUMENTS

The MSE Laboratory performs many types of general chemistry analyses, each involving its own specialized instrumentation. The instruments range from fairly complex chemical analyzers, to hand-held meters, to simple titration vessels; consequently, calibration requirements vary greatly depending on the nature and complexity of the instrument in question. Calibration requirements for each analysis are summarized in Appendix B, Table 1 (general chemistry), and Appendix B, Table 2 (ion chromatograph only).

5.6 METALS INSTRUMENTS

Instruments used for metals analyses (ICP-AES, ICP-MS, GFAAS, and CVAAS) are calibrated at least once daily or every 12 operating hours, whichever is more frequent. Detailed calibration requirements for each instrument are presented in Appendices C, Tables 1 through 12.

5.7 BACTERIOLOGICAL INSTRUMENTS

The primary instruments associated with bacteriological analyses include autoclaves, incubators, and balances. Additionally, beakers, flasks, petri dishes, and sample containers must be frequently checked for sterility to ensure that sample cultures are not affected by contamination. Quality control and calibration requirements are summarized in Appendix D.

6. DATA QUALITY/LABORATORY EVALUATION

6.1 OVERVIEW

Performance evaluations of the MSE Laboratory, in terms of both data quality and analytical procedures, are accomplished by:

- internal data review;
- data validation procedures;
- internal and external performance audits; and
- analysis of blind performance samples obtained from National Environmental Laboratory Accreditation Conference (NELAC) certified vendors twice per calendar year.

These performance evaluation activities are discussed further in Sections 6.2, 6.3, 6.4, and 6.5.

6.2 INTERNAL DATA REVIEW

All analytical data generated by the MSE Laboratory undergo a formal review prior to their submittal to clients. There are some differences in the review procedures used for general chemistry data versus metals data, as discussed in the following subsections.

6.2.1 General Chemistry Data

General chemistry data are commonly recorded in bound logbooks at the time of analysis. In general, separate logbooks are maintained for each type of analysis performed. The analyst or technician performs the initial data review. Each logbook page is further reviewed by a qualified member of the MSE Laboratory staff (see Section 1.6.4). These results are reviewed for completeness and also for compliance with the QA Requirements/Control Limits for general chemistry (Appendix B, Table 1) and/or ion chromatograph (Appendix B, Table 2). After the analytical report is completed, a final review process occurs, wherein the data are reviewed for transcription errors and for other more qualitative QA issues.

While each general chemistry analysis is recorded in a bound logbook, several analysis types involving automated methods also generate individual data printouts for each instrument run. These data are reviewed in the same manner as the general chemistry logbooks, with each data printout being dated and initialed by the reviewer, along with any QA issues requiring action.

6.2.2 Metals Data

Metals data are produced by the ICP-AES, ICP-MS, GFAAS, and CVAAS. Each instrument generates a separate data printout for each instrument run. The first level of review is performed by the instrument operator, who checks results for compliance with the metals QA Requirements/Control Limits in Section 2.3.2. Any problems are reviewed with the Production Manager or Chief Analytical Chemist to determine whether reanalysis is necessary. The data printouts are then assembled in a draft data report.

Next, the draft report is reviewed by the QA Officer, Laboratory Manager, and/or a qualified staff member (different from the person preparing the report). To facilitate consistency in review procedures, each instrument run is stamped with a review form, which then is completed by the reviewer. The run is reviewed in its entirety for compliance with the metals QA objectives and for any other suspect behavior. Any QA issues are noted below this stamped form. Figure 6-1 shows the stamped data review form for each of the metals analysis instruments.

6.2.3 Bacteriological Data

Bacteriological data are reviewed by the MSE Laboratory's Certified Bacteriological Analyst prior to release.

If results for a public (defined as more than 10 hookups) water supply are found unsatisfactory, the Montana Water Quality Bureau and the public water supply are notified immediately by phone. In such cases, additional sampling will be required, as discussed in Bacterial Procedures used for Examination of Potable Water Supplies (MSE, 2004a).

6.3 CORRECTIVE ACTION

Corrective actions (CAs) are actions taken in response to nonconformance reports issued during audits, technical reviews, and findings from a performance evaluation failure or data review finding. All conditions that adversely affect data quality must be identified and corrected. Once a problem has been identified, the QA Officer will contact the Chief Analytical Chemist. The Chief Analytical Chemist will investigate the cause and is responsible for ensuring CA implementation and effectiveness.

A Corrective Action Logbook is maintained in the sample receiving area to track data quality problems. The Corrective Action Logbook is a chronological listing of all data quality problems found during review processes that necessitated sample reanalyses. All CAs implemented will be documented in this logbook.

Each entry includes:

- laboratory sample numbers affected by the problem;
- a description of the result(s) necessitating the reanalyses;
- original sample analysis date(s);
- corrective action taken;
- date(s) of sample reanalyses; and
- an evaluation of whether the corrective action taken yielded satisfactory results.

A sample page from the Corrective Action Logbook is shown in Figure 6-2.

6.4 DATA VALIDATION PROCEDURES

While all reported data undergoes a formal review, clients are increasingly requesting formal data validation reports, which include:

- discussions of the data quality indicators;
- assignment of data flags and qualifiers commonly used under the EPA CLP; and
- completed data validation forms.

An example of a data validation forms used by the MSE Laboratory is presented in Figure 6-3.

6.5 INTERNAL AND EXTERNAL PERFORMANCE AUDITS

The MSE Laboratory QA Officer conducts an internal performance audit once per year. A standard audit questionnaire developed by the State of Montana Laboratory Certification Division is used as the basis to ensure consistency with laboratory certification requirements (see Appendix E). Also, specific issues are addressed as indicated by problems and concerns noted during the preceding year. A formal report/memorandum identifying any deficiencies is issued and distributed to MSE Laboratory personnel within 2 weeks from the conclusion of the audit. A follow-up check is performed 1 month afterward to ensure that report findings have been satisfactorily addressed.

Additionally, audits are conducted by the State of Montana's Laboratory Certification Division and also by several of the MSE Laboratory's primary clients on an as-needed basis. These typically involve:

- advance review of laboratory records by the auditing entity;
- an on-site inspection of 1 to 2 days duration;
- preparation of written audit findings/observations report by the auditing entity; and,
- a written response by the MSE Laboratory describing corrective actions to be taken to address any findings/observations.

6.6 ANALYSIS OF BLIND PERFORMANCE SAMPLES

As part of the MSE Laboratory's Montana Drinking Water Certification, blind samples from an outside vendor are analyzed twice per year. The analyses include all certified analytical parameters. The vendor then provides results for each analysis type showing the known values, reported laboratory results, and acceptance ranges. These results are also sent to the State certifying agency. Any unacceptable results are reviewed for indications of problems related to analytical standards, instrument performance, and/or other MSE Laboratory issues until the problem is identified and corrected.

ICP-AES

DATE________
INITIALS________
BIF#________
BATCH#________
ICV / CCV________
ICB / CCB / PB________
ICSA / ICSAB________
LCS / DUP / LMS________
SERIAL DIL________
REMARKS:

ICP-MS

DATE________
INITIALS________
BIF#________
BATCH#________
ICV / CCV________
ICB / CCB / PB________
ICSA / ICSAB________
LCS / DUP / LMS________
RSD________
INTERNAL STDS________
SERIAL DIL________

REMARKS:

GFAAS

DATE________
INITIALS________
BIF#________
BATCH#________
ICV / CCV________
ICB / CCB / PB________
LCS / DUP / LMS________
STD ADDITIONS________

REMARKS:

MERCURY

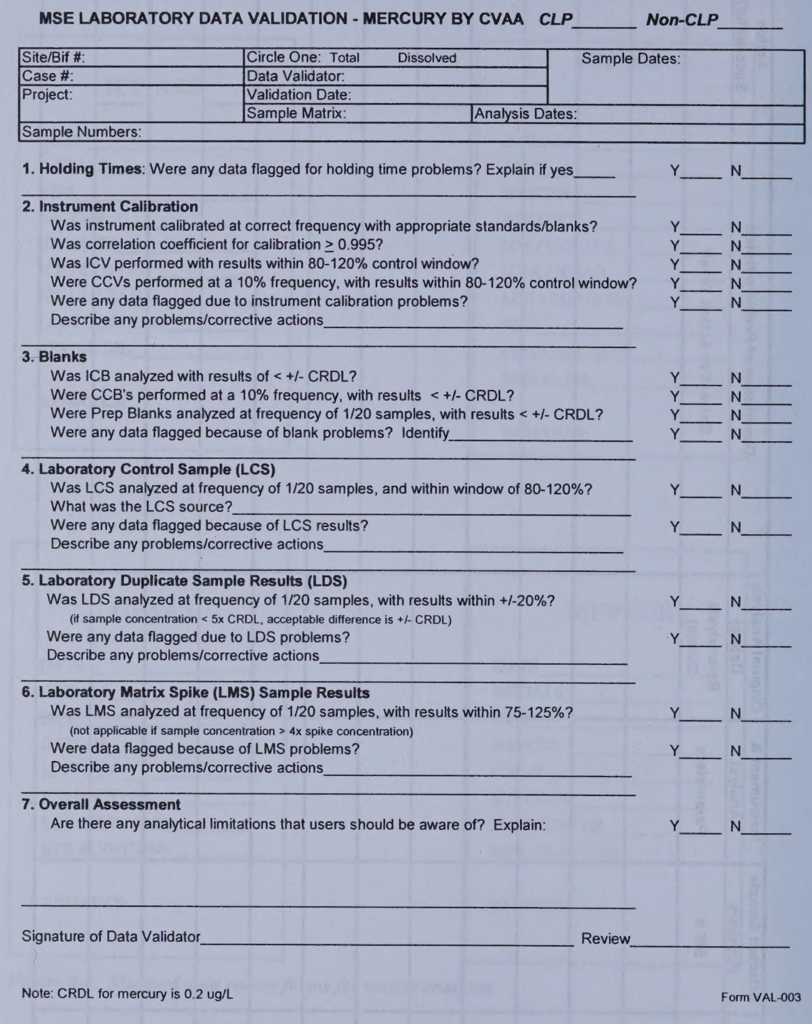
DATE________
INITIALS________
BIF#________
BATCH#________
CAL-R________
ICV / CCV________
ICB / CCB / PB________
LCS / DUP / LMS________

REMARKS:

Figure 6-1. Stamped data review forms for metals analyses.

Initials	Affected Sample Numbers	Instrument & Analyst	Original Analysis Date(s)	Description of Problem Noted	Action Successful?
Date	BIF #	Parameters	Re-analysis Date(s)	Corrective Action Taken	

Figure 6-2. Corrective Action Logbook.



MSE LABORATORY DATA VALIDATION - MERCURY BY CVAA ***CLP*****______** ***Non-CLP*****______**

Site/Bif #:	Circle One: Total Dissolved	Sample Dates:
Case #:	Data Validator:	
Project:	Validation Date:	
	Sample Matrix:	Analysis Dates:
Sample Numbers:		

1. Holding Times: Were any data flagged for holding time problems? Explain if yes_____ Y_____ N______

2. Instrument Calibration

Was instrument calibrated at correct frequency with appropriate standards/blanks? Y_____ N______
Was correlation coefficient for calibration ≥ 0.995? Y_____ N______
Was ICV performed with results within 80-120% control window? Y_____ N______
Were CCVs performed at a 10% frequency, with results within 80-120% control window? Y_____ N______
Were any data flagged due to instrument calibration problems? Y_____ N______
Describe any problems/corrective actions______________________________

3. Blanks

Was ICB analyzed with results of < +/- CRDL? Y_____ N______
Were CCB's performed at a 10% frequency, with results < +/- CRDL? Y_____ N______
Were Prep Blanks analyzed at frequency of 1/20 samples, with results < +/- CRDL? Y_____ N______
Were any data flagged because of blank problems? Identify________________ Y_____ N______

4. Laboratory Control Sample (LCS)

Was LCS analyzed at frequency of 1/20 samples, and within window of 80-120%? Y_____ N______
What was the LCS source?______________________________
Were any data flagged because of LCS results? Y_____ N______
Describe any problems/corrective actions______________________________

5. Laboratory Duplicate Sample Results (LDS)

Was LDS analyzed at frequency of 1/20 samples, with results within +/-20%? Y_____ N______
(if sample concentration < 5x CRDL, acceptable difference is +/- CRDL)
Were any data flagged due to LDS problems? Y_____ N______
Describe any problems/corrective actions______________________________

6. Laboratory Matrix Spike (LMS) Sample Results

Was LMS analyzed at frequency of 1/20 samples, with results within 75-125%? Y_____ N______
(not applicable if sample concentration > 4x spike concentration)
Were data flagged because of LMS problems? Y_____ N______
Describe any problems/corrective actions______________________________

7. Overall Assessment

Are there any analytical limitations that users should be aware of? Explain: Y_____ N______

Signature of Data Validator______________________________ Review________________

Note: CRDL for mercury is 0.2 ug/L

Form VAL-003

Figure 6-3. Example of data validation form.

7. LABORATORY STANDARDS AND GENERAL PRACTICES

7.1 OVERVIEW

The following sections describe the analytical standards used by the MSE Laboratory for sample analyses, as well as general laboratory practices that are necessary for the generation of repeatable, high-quality data.

7.2 ANALYTICAL STANDARDS

MSE Laboratory analytical standards can be divided into:

- general chemistry standards;
- metals standards; and
- bacteriological standards.

Each type of standard is discussed in the following paragraphs.

7.2.1 General Chemistry Standards

For general chemistry analyses, the MSE Laboratory uses numerous inorganic standards, that are typically certified to contain a known concentration of a particular ion or to have an otherwise known quantitative chemical or physical property. These standards are either purchased from laboratory suppliers or prepared in the MSE Laboratory from known standards.

Like the multi-element standards, these standards, whether purchased or prepared, are identified by sequential numbers prefaced by a "Q." They are logged in a bound logbook (referred to as the "Q" Book), along with the date of receipt or preparation plus the expiration date. The certification sheets are stored in a designated loose-leaf binder. The "Q" book is labeled "L-GP-QBook" and the COA binders are labeled "Multi-Element COAs."

7.2.2 Metals Standards

7.2.2.1 Single Element Metals Standards

Single element standard stock solutions are procured from laboratory suppliers and consist of a known concentration of a single element in a known medium (usually water plus a small amount of acid). These solutions are usually certified contaminant-free (i.e., contaminant concentrations are below stated threshold values). Single element standards are typically certified for a period of 18 months.

All single element standards are logged in a bound logbook (L-GP-SSTDS), and the original certification sheet is kept in a designated loose-leaf binder (Single Element COAs). Each container is assigned a unique, sequential identifying MSE Laboratory number. The documentation also includes a record of the date the standard was received plus a certification expiration date.

7.2.2.2 Multi-Element Metals Standards

The MSE Laboratory uses numerous multi-element standards that are either purchased from laboratory suppliers or prepared in the MSE Laboratory from the single element standards described in Section 7.2.2.1. Samples purchased externally include certificates of analysis with an expiration date. Standards prepared in the MSE Laboratory are considered valid for a period of 6 months or at the earliest expiration date of the single element standards of which it consists, whichever is earlier.

Like the general chemistry standards, the multi-element metals standards, whether purchased or prepared, are identified by sequential numbers prefaced by a "Q." They are logged in a bound logbook (referred to as the "Q" Book) along with the date of receipt or preparation plus the expiration date. The certification sheets are stored in a designated loose-leaf binder. The Q book is labeled "L-GP-QBook" and the binders are labeled "Multi-Element COAs."

7.2.3 Bacteriological Standards

Standards used for bacteriological analyses include a variety of media used to facilitate growth of bacterial cultures. These are certified free of impurities by the manufacturers and undergo continued testing for sterility following their use in bacterial analysis preparations. These media are detailed in Bacterial Procedures used for Examination of Potable Water Supplies (MSE, 2004a). All media information is recorded in a bound logbook labeled "L-BT-MEDIA."

7.3 GENERAL LABORATORY PRACTICES

7.3.1 Preparation of Glassware

The generation of high-quality data requires the use of laboratory glassware that is free of contamination. Glassware is prepared in accordance with SOP No. GP001, "Laboratory Glassware Cleaning Procedures."

7.3.2 Laboratory Housekeeping

Each technician/analyst is responsible for keeping his/her immediate work area clean. When sample analyses are complete, the responsible analyst returns the unused portion of the samples to the sample bank, replaces reagents and chemicals in the appropriate chemical storage area, and places dirty glassware in the glassware cleaning area. Additionally, key individuals are assigned the responsibility of MSE Laboratory maintenance of primary work areas (e.g., chemical storage, laboratory equipment storage, inorganic preparation area, sample bank, and sample receiving area).

8. COMPUTER HARDWARE AND SOFTWARE

8.1 COMPUTER HARDWARE AND SOFTWARE POLICY

With computers playing a critical and important role in the daily operations of the MSE Laboratory, it is essential that the LIMS, LAN, and data systems be adequately and appropriately documented. The MSE Laboratory is kept up to date with documented operating manuals and instrument maintenance contracts (where applicable). Additionally, the MSE Laboratory keeps written, hardbound maintenance logbooks for all analytical instruments. Software is purchased with full licenses for all hardware units installed with the software. All computer hardware and software is kept up to date to meet all applicable MSE Engineering standards.

8.2 LOCAL AREA NETWORK

The MSE LAN is maintained by the MSE Network Administrator. The LAN is used primarily for data communication and reporting. All LAN issues must be addressed through the MSE Network Administrator.

9. REFERENCES

APHA, 1995, Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, and Water Environment Federation, 19th Edition, 1995.

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EPA, 1999, EPA 821-R-99-017, Method 200.8: Determination of Trace Elements in Water and Waste by Inductively Coupled Plasma - Mass Spectrometry, Revision 5.5, October 1999.

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MSE, 2004b, Chemical Hygiene Plan, MSE Technology Applications, Inc. Laboratory, October 2006.

USDA, 1954, USDA Agriculture Handbook No. 60, Diagnosis and Improvement of Saline and Alkali Soils, February 1954.

APPENDIX A

SOP Master List

MSE Laboratory Services
Standard Operating Procedures – Master List

SOP Number	Title	Rev. Date
General Practices		
SOP001	Guidelines for Preparation, Review, Approval, and Management of SOPs	10-17-06
GP001	Labware Cleaning Procedures	10-17-06
GP002	Quality Control Charts and Determination of Quality Control Criteria for Precision and Accuracy	10-17-06
GP004	Analytical Balance Calibration	10-17-06
GP005	Procedure for Accepting and Logging in Samples	10-17-06
GP007	Raw Data Review, Summary and Reporting	10-17-06
GP011	Receipt and Log-In of QA/QC Standards (Liquid and Solid)	10-17-06
GP012	Refrigerator Temperature Checks	10-17-06
GP013	Gravity Convection Ovens Temperature Check	10-17-06
GP014	Deionized Water System Daily Check	10-17-06
GP018	Operation, Calibration, and Maintenance of Mechanical Pipettes	10-17-06
GP025	Corrective Action Plan	10-17-06
GP028	Sample Kit Preparation	10-17-06
GP029	MDL Studies, Initial Demonstration of Capabilities, and Performance Evaluation Studies	10-17-06
GP030	Identification System for Laboratory Documentation	10-17-06
GP031	Statistical Identification of Outliers (Extreme Studentized Deviate) Grubbs' Test	10-17-06
GP032	Procedure for Calibration of Laboratory Thermometers	10-17-06

MSE Laboratory Services
Standard Operating Procedures – Master List

SOP Number	Title	Rev. Date
Analytical Methods		
AM006	Mercury in Soils, Sludges, and Sediment by CVAAS, EPA CLP SOW ILM05.3/ (Draft)ILM06.X	10-17-06
AM007	Aqueous Mercury by CVAAS, EPA CLP SOW ILM05.3/(Draft)ILM06.X	10-17-06
AM008	Determination of Percent Solids, SM 2540 G	10-17-06
AM012	Leco Sulfur Determination	10-17-06
AM013A	Determination of Arsenic III and Arsenic V in Water Samples - Flicklin	10-17-06
AM013B	Determination of Iron II and Iron III in Water Samples, SM3500-Fe D. Phenanthroline Method	10-17-06
AM015	Acid-Based Accounting (ABA)	10-17-06
AM016	Particle Size Analysis by Hydrometer/USDA Texture Classification	10-17-06
AM017A	Calcium Carbonate Equivalency for Lime Samples	10-17-06
AM017B	Calcium Carbonate Equivalence of Soils	10-17-06
AM020	Total Organic Carbon – Walkley Black Procedure	10-17-06
AM021	Total Organic Carbon – Loss on Ignition Procedure	10-17-06
AM022	Dry and Wet Sieve Analysis – ASTM C602-90	10-17-06
AM024	Determination of Inorganic Anions by Ion Chromatography: EPA Method 300.0	10-17-06

MSE Laboratory Services
Standard Operating Procedures – Master List

SOP Number	Title	Rev. Date
Instrument Methods		
IM001	Operation and Maintenance of the ARL 3560 ICP-AES	10-17-06
IM006	Inductively Coupled Plasma-Atomic Emission (ICP-AES) Method for Analysis of Water and Wastes (EPA Method 200.7)	10-17-06
IM007	Inductively Coupled Plasma-Atomic Emission (ICP-AES) Method for Analysis of Trace Elements in Solution (SW846 Method 6010C)	10-17-06
IM008	ICP-AES EPA CLP ILM05.3/Draft ILM06.X	10-17-06
IM013	Operation and Maintenance of the Varian Spectra A-400 Zeeman GFAAS (Graphite Furnace Atomic Absorption Spectrometer)	10-17-06
IM016	Centrifuge Use	10-17-06
IM020	Operation and Maintenance of the Cetac M6000A CVAA Mercury Analyzer	10-17-06
IM020A	Determination of Mercury in Water by CVAAS (Cold Vapor Atomic Absorption Spectrometry) – EPA Method 245.1	10-17-06
IM020B	Mercury in Aqueous and Sediment Samples by CVAAS, SW846 Methods 7470A and 7471B	10-17-06
IM022	Determination of Trace Elements by GFAAS: EPA Method 200.9	10-17-06
IM023	Determination of Trace Elements by GFAAS: SW846 Method 7010	10-17-06
IM026	Standard Operating Procedure for the Operation and Maintenance of the Perkin Elan 6000 ICP-MS	10-17-06
IM026A	Determination of Trace Elements by ICP-MS: EPA Method 200.8	10-17-06
IM026B	Determination of Trace Elements by ICP-MS: SW846 Method 6020A	10-17-06
IM026C	Determination of Trace Elements by ICP-MS: ILM05.3/(Draft) ILM06.X	10-17-06
IM027	Dionex ICS2500 Ion Chromatograph Operation and Maintenance	10-17-06

MSE Laboratory Services
Standard Operating Procedures – Master List

SOP Number	Title	Rev. Date
Sample Preparation		
SP001A	Total Metals–Water Samples (CLP) ICP-AES, ICP-MS, GFAAS (USEPA ILM06.X)	10-17-06
SP001B	Modified EPA Method 200.2 (Hot Block Procedure)	10-17-06
SP001C	Acid Digestion of Waters for Total Recoverable Metals or Dissolved Metals (Modified Method 3005A)	10-17-06
SP001C-2	Acid Digestion of Waters for Total Recoverable Metals or Dissolved Metals (Modified (2) Method 3005A) for Analysis by ICP-AES, ICP-MS, and GFAAS	10-17-06
SP001D	Total Metals Water Samples (Method 3010A) (ICP-AES)	10-17-06
SP001E	Digestion of Soil Samples for Total Metals (Modified Method 3050B) (ICP-AES)	10-17-06
SP001F	Digestion of Water Samples for Total Metals (Method 3020A) (GFAAS/ICPMS)	10-17-06
SP001H	Total Recoverable Metals Modified for TCLP (Modified Method 3005A)	10-17-06
SP001J	Acid Digestion of Biological Tissues for Total Recoverable Elements (Modified Method 200.3)	10-17-06
SP001K	Digestion of Soil Samples for Total Metals (Modified Method 3050B) (ICPMS/GFAAS)	10-17-06
SP002	Lithium Tetraborate Fusion and Fusion Prep	10-17-06
SP003B	DTPA Extraction of Soils SP004 Toxicity Characteristic Leach Procedure (SW846 1311-TCLP)	10-17-06
SP008	Toxicity Characteristic Leach Procedure (SW846 1311-TCLP)	10-17-06
SP015	Cation-Exchange Capacity of Soils (Sodium Acetate) Method 9081	10-17-06
SP016A	Available "P" Bray Method	10-17-06
SP016B	Phosphorus Sodium Bicarbonate (Method 24-5.4.2)	10-17-06
SP017	Exchangeable and Soluble Potassium (Method 13-3.3)	10-17-06
SP018	1:1 Ph	10-17-06
SP018A	Soil pH and Lime Requirement 1:1 Ph	10-17-06
SP018B	Calcium Chloride 1:1 pH ASA Method 12-2.6.5	10-17-06
SP020	Saturated Paste Extract U.S.D.A. Method 10-2.3	10-17-06
SP021	Available Nitrogen Extraction (Method 33-3.2)	10-17-06

MSE Laboratory Services
Standard Operating Procedures – Master List

SOP Number	Title	Rev. Date
Wet Chemistry		
WC001	Acidity (Titrimetric) EPA Method 305.1 / Standard Method 2310-B	10-17-06
WC002	Alkalinity—Forms (Titrimetric) – SM 2320 B	10-17-06
WC003	Corrosivity (Langelier's Saturation Index)	10-17-06
WC005	Chloride	10-17-06
WC006	Chlorine Free and Total Residual	10-17-06
WC008A	Total Cyanide Distillation EPA 335.2/Standard Methods 4500-C	10-17-06
WC008B	Weak Acid Dissociable Cyanide Distillation	10-17-06
WC009	Fluoride: SM 4500-F C. Ion Selective Electrode Method	10-17-06
WC010	Total Hardness Titration EPA Method 130.2	10-17-06
WC013	Nitrogen, Ammonia—EPA 350.2—Colorimetric Method	10-17-06
WC014	Total Kjeldahl Nitrogen, EPA/351.3	10-17-06
WC015	Nitrate and Nitrite Nitrogen	10-17-06
WC017	Oxidation-Reduction Potential-SM 2580 B	10-17-06
WC018	Operation and Maintenance of the Orion pH Meter and Electrode	10-17-06
WC019B	Ortho-Phosphate	10-17-06
WC019C	Phosphorus, Total – by SM-4500-PE, EPA-365.4	10-17-06
WC021	Total Dissolved Solids (Residue, Filterable) EPA Method 160.1/ Standard Method 2540-C	10-17-06
WC022	Total Suspended Solids (Residue, Non-Filterable) EPA Method 160.2/ Standard Method 2540-D	10-17-06
WC023	Total Solids Standard Method 2540B	10-17-06
WC024	Total Volatile Solids (Residue, Volatile) EPA Method 160.4/ Standards Method 2540-E	10-17-06
WC026	Sulfate (Colorimetric, Automated, Methlythymol Blue) EPA 375.2	10-17-06
WC028	Operation and Maintenance of the HF Micro 100 Turbidimeter (EPA Method 180.1)	10-17-06
WC032	Total Cyanide in Water and Solids Method 335.2	10-17-06
WC033	The Determination of Chemical Oxygen Demand by Semi-Automated Colorimetry and Manual Method (Method 410.4)	10-17-06
WC034	Sulfide in Water–Standard Method 4500-S2- F- Iodometric Method	10-17-06
WC035	Specific Conductance EPA 120.1/Standard Methods 2510-B	10-17-06
WC037	5-Day BOD Test –SM5210 B	10-17-06
WC038	Operation and Maintenance of the Alpkem Segmented Flow Auto Analyzer	10-17-06

APPENDIX B

Wet Chemistry and Ion Chromatography QA/QC Requirements

APPENDIX B, TABLE 1. QA/QC FOR WET CHEMISTRY PARAMETERS – LIQUID MATRIX

Parameter	Method	DW Method (DW)	Calibration Requirements	ICV/QCS	ICB/LRB	CCV/IPC	CCB	LFB	LCS	DUP	SPIKE/LFM	BLANK
COLORIMETRIC												
Ammonia	**EPA 350.2**		Blank + 7 standards	X	X	X	X		X	X	X	X
Chloride	**EPA 325.2**		Blank + 8 standards	X	X	X	X	X	X	X	X	X
Chlorine	**EPA 330.5**	**SM 4500-Cl-G**	Blank + 7 standards	X	X	X	X	DW	X	X		X
Chromium +6		**SM 7196A**	Blank + 6 standards	X	X	X	X		X	X	X	X
COD	**EPA 410.4**		Blank + 5 standards	X	X	X	X		X	X	X	X
Cyanide - TC	**EPA 335.2**	**SM 4500-CN-E**	Blank + 3 standards	X	X	X	X	DW	X	X	X	X
Cyanide WAD	**EPA 335.2**	**SM 4500-CN-E**	Blank + 3 standards	X	X	X	X	DW	X	X	X	X
Iron Speciation		**SM 3500-Fe D**	Blank + 6 standards	X	X	X	X		X	X		
Nitrate/Nitrite	**EPA 353.2**		Blank + 8 standards	X	X	X	X	X	X	X	X	X
Nitrite	**EPA 353.2**		Blank + 7 standards	X	X	X	X	X	X	X	X	X
Phosphorus - Ortho	**EPA 365.3**	**SM 4500-P-E**	Blank + 6 standards	X	X	X	X			X	X	
Phosphorus - Total	**EPA 365.4**		Blank + 6 standards	X	X	X	X			X	X	X
Sulfate	**EPA 375.2**		Blank + 8 standards	X	X	X	X	X	X	X	X	X
Total Kjeldahl Nitrogen	**EPA 351.2**		Blank + 7 standards	X	X	X	X		X	X	X	X
Turbidity	**EPA 180.1**		Blank + 3 standards						X	X		X
ELECTROCHEMICAL												
Conductivity	**EPA 120.1**	**SM 2510B**	Blank + 3 standards	X	X	X	X			X		
Fluoride	**EPA 340.2**	**SM 4500-F-C**	5 standards	X	X	X	X	X		X	X	
pH	**EPA 150.1**		Check at pH of 4, 7, 10	X	X	X	X			X		
GRAVIMETRIC												
Sulfide - Acid Volatile		*	Check balance						X	X	X	X
TDS	**EPA 160.1**	**SM 2540C**	Check balance						X	**		X
TSS	**EPA 160.2**		Check balance						X	X		X
TVS	**EPA 160.4**		Check balance						X	X		X
TITRIMETRIC												
Acidity	**EPA 305.1**		3 blanks						X	X		X
Alkalinity	**EPA 310.1**	**SM 2320B**	None						X	X		X
Hardness	**EPA 130.2**		None						X	X	X	X
Sulfide	**EPA 376.2**		3 iodine blanks						X	X	X	X
Frequency			START	START	START	A	B	D	D	D	C	D
Control Limits: (1) = 90-110%R; (2) = +/- 2xMDL; (3) = 85-115%R; ***(4) = 80-120%R; (5) = 20% RPD; (6) = 75-125%R***				(1)	(2)	(1)	(2)	(3)	(4)	(5)	(6)	(2)

Criteria (5) N/A for sample conc. < 5 x MDL
Criteria (6) N/A for sample conc. >4 x SPIKE/LFM

(DW) Note: For drinking water analyses, the methods listed under "DW Method" must be used, rather than the corresponding EPA Method.

LEGEND

X = Done for all analyses of this parameter
DW = Done for drinking water analyses only
* - EPA Research Laboratory, April 1991
** - RPD <10% when TDS > 500 mg/L;
Abs. Diff. <46 mg/L when TDS<500mg/L

FREQUENCY NOTES

START = At start of instrument/analysis run
A = Once every 10 instrument readings, excluding CCV/IPC, CCB, and internal instrument electronics checks
B = Same as A; occurs immediately following CCV/IPC
C = Once per 10 samples (drinking water)/once per 20 samples (other); or once per batch, whichever is more frequent
D = Once per 20 samples or once per batch, whichever is more frequent

APPENDIX B, TABLE 2. QA/QC REQUIREMENTS FOR ION CHROMATOGRAPH – METHOD 300.0

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Fortified Blank (LFB)	1/SDG	90-110% R	Determine source of problem and correct before continuing with analyses.
Laboratory Reagent Blank (LRB)	1/SDG	<RL	Identify source of contamination and prepare fresh sample aliquots and reanalyze.
Laboratory Duplicate Sample (D)	1/10 samples	≤ 20% R	Flag/qualify samples as appropriate.
Laboratory Fortified Sample Matrix (LFM)	1/10 samples	80-120% R (not calc. if spike conc. is <25% of sample conc.) Same concentration as LFB	Flag/qualify samples as appropriate.
Quality Control Sample (QCS)	Quarterly	90-110% R	Determine source of problem and correct before analyzing samples.
Instrument Performance Check (IPC)	Initial/Final/ 1/10 samples	90-110%R	Determine source of problem and correct. Re-analyze IPC. If results still out, recalibrate instrument and re-run all samples since last compliant IPC.
Calibration Blank (CB)	After each IPC	<RL	Reanalyze CB. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant CB.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and five standards.

INITIAL DEMONSTRATION OF CAPABILITIES:
LDR: Initially, then every 6 months.
QCS: Initially, then quarterly.
MDL: Initially, then every 6 months, also with change in instrument hardware or operating conditions.

NOTES:
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.
RL = See Table 3 of SOP #AM024 for reporting limits.

APPENDIX C

Inorganics, Metals QA/QC Requirements

APPENDIX C, TABLE 1. QA/QC LIMITS FOR ICP-AES – METHOD 200.7 CLP-M, ILMO5.3/DRAFT ILMO6.X MODIFIED

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- CRQL	If blank > CRDL, re-digest/reanalyze all samples associated with PB/LRB, unless sample conc. > 10x blank conc.
			If blank < -CRDL, re-digest/reanalyze all samples < 10X absolute blank value.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (R)	1/SDG	RPD≤ 20% for sample conc. > 5*CRQL;+/- CRQL for sample conc. < 5*CRQL	Flag/qualify samples as appropriate.
Laboratory Matrix Spike (LFM)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Instrument Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	After ICB, then 1/10 samples	90-110% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Instrument Calibration Blank (ICB)	After each ICV	+/- CRQL	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- CRQL	Recalibrate instrument and re-run all samples since last compliant CCB.
Interference Check Solution A (ICSA)	Beginning and end of run, every 20 samples	+/- CRQL for target analytes	Recalibrate instrument, re-run samples.
Interference Check Solution B (ICSAB)	Beginning and end of run, every 20 samples	80-120% R	Recalibrate instrument and re-run all samples since last compliant interference check.
Analytical Spike (A)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
CRQL Standard	Beginning and end of run	70-130% R except Sb, Pb, and Tl at 50-150% R. N/A for Al, Ba, Ca, Fe, Mg, Na, K	Used to verify linearity near the CRDL.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if sample conc. < 50*MDL	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard.

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
CRQL = EPA Contract Required Quantitation Limit.
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 2. QA/QC LIMITS FOR GFAAS – METHOD 200 SERIES CLP-M, ILMO1.0

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- CRQL	If blank > CRQL, re-digest/reanalyze all samples associated with PB, unless sample conc. > 10x blank conc.
			If blank < -CRQL, re-digest/reanalyze all samples < 10X absolute value of blank result.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (R)	1/SDG	≤ 20% RPD for conc. > 5*CRQL +/- CRDL for conc. < 5*CRQL	Flag/qualify samples as appropriate.
Laboratory Matrix Spike (S)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Instrument Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	After ICB, then 1/10 samples	90-110% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Instrument Calibration Blank (ICB)	After each ICV	+/- CRQL	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- CRQL	Recalibrate instrument and re-run all samples since last compliant CCB.
Duplicate Injections	Each sample (incl. QA samples)	<= 20% for conc. > CRQL	Rerun sample once; then flag/qualify as appropriate.
Analytical Spike (A)	Each sample (incl. QA samples)	85-115% SSR	Perform MSA and/or flag & qualify data as appropriate.
CRQL Standard	1/SDG	None	Used to verify linearity near the CRQL.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of 3 levels plus a blank (one standard at CRDL).

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
CRQL = EPA Contract Required QUANTITATION Limit, ICP-MS.
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 3. QA/QC LIMITS FOR CVAAS – METHOD 245.1 SERIES CLP-M, ILMO5.3/DRAFT ILMO6.X

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- 0.2 μg/L	If blank > CRQL, re-digest/reanalyze all samples associated with PB/LRB, unless sample conc. > 10x blank conc.
			If blank < -CRQL, re-digest/reanalyze all samples < 10X absolute value of blank result.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (S)	1/SDG	RPD ≤ 20% for sample conc.>1.0 μg/L otherwise +/- 0.2 μg/L	Flag/qualify samples as appropriate.
Laboratory Matrix Spike (S)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Instrument Calibration Verification (ICV)	After each calibration	80-120% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	After ICB, then 1/10 samples	80-120% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Instrument Calibration Blank (ICB)	After each ICV	+/- 0.2 μg/L	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- 0.2 μg/L	Recalibrate instrument and re-run all samples since last compliant CCB.
CRQL Standard	1/SDG	N/A	Used to verify linearity near the CRQL.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and five standards.

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, the second to non-digested samples.

SDG = Sample Delivery Group (maximum size = 20 samples).
CRQL = EPA Contract Required QUANTITATION Limit of 0.2 μg/L (ILMO5.3).
R denotes recovery, e.g. R of 80% denotes 80% of expected result was obtained.

APPENDIX C, TABLE 4. QA/QC LIMITS FOR ICP-MS – METHOD 200.8 CLP-M, ILMO5.3/DRAFT ILMO6.X - Modified

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Internal Standards	Each sample	60-125%R	Dilute 2X and reanalyze; if still out, flag
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- CRQL	If blank > CRQL, re-digest/reanalyze all associated samples, unless sample conc. > 10x blank. If blank < -CRQL, re-digest/reanalyze all samples < 10X absolute value of blank result.
Laboratory Duplicate Sample (D)	1/SDG	RPD ≤ 20% for samp. conc. > 5*CRQL +/- CRQL for sample conc. < 5*CRQL	Flag/qualify samples as appropriate.
Laboratory Matrix Spike (S)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Instrument Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	After ICB, then 1/10 samples	90-110% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Instrument Calibration Blank (ICB)	After each ICV	+/- CRQL	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- CRQL	Recalibrate instrument and re-run all samples since last compliant CCB.
Interference Check Solution A (ICSA)	Beginning and end of run, every 20 samples	Zero +/- 2*CRQL for target analytes w/ CRQL <= 10 µg/L, otherwise +/- 20%	Recalibrate instrument and re-run all samples since last compliant interference check.
Interference Check Solution B (ICSB)	Beginning and end of run, every 20 samples	80-120% R	Recalibrate instrument and re-run all samples since last compliant interference check.
Post-Digestion (Analytical) Spike (A)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
CRQL Standard	Beginning and end of run, plus every 20 samples	80 - 120% R	Re-run CRI, if still out of compliance, recalibrate and reanalyze since last compliant CRI.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if sample conc. < 50*MDL	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard. Must analyze tuning solution at least 5 times during pre-calibration sequence. Daily optimization RSD ≤ 5%. Tuning: Peak width at 5% peak height must be within 0.75 amu.

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, and the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
CRQL = EPA Contract Required Quantitation Limit.
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.
Cl- interference corrections must be made on all samples, regardless of HCl addition.

APPENDIX C, TABLE 5. QA/QC LIMITS FOR ICP-AES – METHOD 200.7

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Fortified Blank (LFB)	1/SDG	85-115% R	Determine source of problem and correct before continuing with analyses.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- 2*MDL	Identify source of contamination and prepare fresh sample aliquots and reanalyze.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (R)	1/10 samples	≤ 20% RPD for sample conc. > 5*MDL +/- 2*MDL otherwise	Flag/qualify samples as appropriate.
Laboratory Fortified Sample Matrix (LFM)	1/10 samples	70-130% R Same concentration as for LFB	Flag/qualify samples as appropriate.
Instrument Performance Check (IPC)	1/10 samples	95-105% R for first IPC 90-110% R for subsequent IPCs	Re-analyze IPC. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant IPC.
Quality Control Standard (QCS)	Initially and Quarterly	95-105% R (mean of triplicate analysis)	Identify and correct source of problem before proceeding with IDC or ongoing analysis.
Continuing Calibration Blank (CCB)	After each IPC	+/- 2*MDL	Reanalyze CCB. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant CCB.
Spectral Interference Check Solution (ICSA & ICSAB)	Daily	80-120% R	Update interelement correction factors if necessary.
Post-Digestion (Analytical) Spike (A)	1/10 samples	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if sample conc. < 50*MDL	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard.

INITIAL DEMONSTRATION OF CAPABILITIES:
LDR: Initially and annually thereafter.
QCS: Initially, then quarterly or w/new operator
MDL: Initially and annually thereafter, w/new operator, whenever change in instrument hardware or operating conditions.

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, and the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 6. QA/QC LIMITS FOR GFAAS – METHOD 200.9

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Fortified Blank (LFB)	1/SDG	85-115% R	Determine source of problem and correct before continuing with analyses.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- 2*MDL	Identify source of contamination and prepare fresh sample aliquots and reanalyze.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (R)	1/Batch	≤ 20% RPD for sample conc. > 5*MDL +/- 2*MDL otherwise	Flag/qualify samples as appropriate.
Laboratory Fortified Sample Matrix (LFM)	1/10 samples	70-130% R Same concentration as for LFB	%R< 70%, check A spike. If A<85%, MSA. %R>130%, check A spike. If A<85%, flag data. If A>115%, MSA.
Instrument Performance Check (IPC)	1/10 samples	95-105% R for 1st IPC 90-110% R for subsequent IPCs	If results are outside criteria, re-calibrate and re-run all samples since last good IPC.
Quality Control Standard (QCS)	Initially and Quarterly	90-110% R (mean of triplicate analysis)	Identify and correct source of problem before proceeding with IDC or ongoing analysis.
Continuing Calibration Blank (CCB)	1/10 samples	+/- 2*MDL	Reanalyze CCB. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant CCB.
Post-Digestion (Analytical) Spike (A)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and at least 3 standards. Must analyze optimization solution at least 5 times prior to sample analysis; RSD must be less than 5%.

INITIAL DEMONSTRATION OF CAPABILITIES:
LDR: LDR check quarterly
QCS: Initially, then quarterly or w/new operator
MDL: Initially and annually thereafter, w/new operator, whenever change in instrument hardware or operating conditions.

NOTES: (1) Where 2 parameters are listed, the first applies to digested samples, and the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 7. QA/QC LIMITS FOR CVAAS – METHOD 245.1

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Laboratory Fortified Blank (LFB)	1/SDG	85-115% R (concentration = 1 to 4 µg/L) Same concentration as LFM	Determine source of problem and correct before continuing with analyses.
Laboratory Reagent Blank (LRB)	1/SDG	+/- 0.1 µg/L	Identify source of contamination and prepare fresh sample aliquots and reanalyze.
Laboratory Duplicate Sample (D)	1/10 samples	≤ 20% for sample conc. > 1.0 µg/L +/- 0.2 µg/L otherwise	Flag/qualify samples as appropriate.
Laboratory Fortified Sample Matrix (LFM)	1/10 samples	70-130% R Same concentration as LFB & QCS	Flag/qualify samples as appropriate.
Quality Control Sample (QCS)	Quarterly	90-110% R	Determine source of problem and correct before analyzing samples.
Instrument Performance Check (IPC)	Initial/Final/ 1/10 samples	95-105% R for first IPC 90-110%R for subsequent IPCs	Re-analyze IPC. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant IPC.
Continuing Calibration Blank (CCB)	After each IPC	+/- 0.1 µg/L	Reanalyze CCB. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant CCB.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and five standards.

INITIAL DEMONSTRATION OF CAPABILITIES:
LDR: Initially and annually thereafter.
QCS: Initially, then quarterly or w/new operator
MDL: Initially and annually thereafter, w/new operator, whenever change in instrument hardware or operating conditions.

NOTES:
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 8. QA/QC LIMITS FOR ICP-MS – METHOD 200.8

Parameter (1)	Frequency	Acceptance Criteria	Corrective Action
Internal Standards	Each sample	60-125% R	Re-calibrate/reanalyze until acceptable.
Laboratory Fortified Blank (LFB)	1/SDG	85-115% R	Determine source of problem and correct before continuing with analyses.
Preparation Blank (PB) Laboratory Reagent Blank (LRB)	1/SDG	+/- 2*MDL	Identify source of contamination and prepare fresh sample aliquots and reanalyze.
Laboratory Duplicate Sample (D) Laboratory Replicate Sample (R)	1/Batch	< 20% RPD for sample conc. > 5*MDL +/- 2*MDL otherwise	Flag/qualify samples as appropriate.
Laboratory Fortified Sample Matrix (LFM)	1/10 samples	70-130% R Same concentration as for LFB	Flag/qualify samples as appropriate.
Instrument Performance Check (IPC)	1/10 samples	95-105% R for first IPC 90-110% R for subsequent IPCs	If results fail but are within 85-115%, recalibrate and continue analyses. If results are outside 85-115%, re-calibrate and re-run all samples since last good IPC.
Quality Control Standard (QCS)	Initially and Quarterly	90-110% R (mean of triplicate analysis)	Identify and correct source of problem before proceeding with IDC or ongoing analysis.
Continuing Calibration Blank (CCB)	1/10 samples	+/- 2*MDL	Reanalyze CCB. If results still out, determine cause, recalibrate instrument if due to drift, and re-run all samples since last compliant CCB.
Post-Digestion (Analytical) Spike (A)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if sample conc. < 50*MDL	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard. Must analyze tuning solution at least 5 times during pre-calibration sequence.

INITIAL DEMONSTRATION OF CAPABILITIES:
LDR: Initially and annually thereafter.
QCS: Initially, then quarterly or w/new operator.
MDL: Initially and annually thereafter, w/new operator, whenever change in instrument hardware or operating conditions.

NOTES:
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.

APPENDIX C, TABLE 9. QA/QC LIMITS FOR ICP-AES – MOD. SW-846 METHOD 6010C

Parameter (1)	Frequency	Acceptance Criteria/Comments	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% for water Manufacturer's limits for soil	Re-run once, if still out re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB)	1/SDG	+/- 3*MDL <0.1 mg/L Ca, Mg ,Na ,K, Si	Re-run once; if still unacceptable, re-digest/reanalyze all samples associated with PB. If all samples in batch are < DQOs, but PB is > limits, data is still considered reportable.
Duplicate	1/SDG may be used instead of MSD	≤ 20% RPD for sample conc. > 5*MDL +/- 2*MDL otherwise	Flag/qualify samples as appropriate.
Laboratory Matrix Spike (MS)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Check "A" spike and serial dilution results. Flag/qualify samples as appropriate.
Matrix Spike Duplicate (MSD)		<= 20% RPD; 75- 125% R for spike	Check "A" spike and serial dilution results. Flag/qualify samples as appropriate.
Instrument Calibration Verification (ICV)	After each calibration	90-110% R; RSD<= 5%	Recalibrate instrument.
Low Level Continuing Calibration Verification (LLCCV) (50X of CCV)	Beginning of run	80-120% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	1/10 samples	90-110% R, RSD<=5%	Recalibrate instrument and re-run all samples since last compliant CCV.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- 3*MDL <0.1 mg/L Ca, Mg, Na, K, Si	Recalibrate instrument and re-run all samples since last compliant CCB.
Interference Check Solution A (ICSA)	Beginning and end of run, every 20 samples	Analytes: Zero +/- 3*MDL Interferents: 80-120 %R	Recalibrate instrument, re-run samples.
Interference Check Solution B (ICSAB)	Beginning and end of run, every 20 samples	80-120% R	Recalibrate instrument and re-run all samples since last compliant interference check.
Analytical Spike (A)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Investigate/identify source of interference, rerun samples if appropriate.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if conc. < 10*MDL	Flag/qualify samples as appropriate. Only applies if MS, MSD, A-Spike fail.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard.

NOTES: (1) Where 2 parameters are shown, the first applies to digested samples, and the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
%R denotes percent recovery, e.g. R of 90% denotes 90% of expected result was obtained.
See method specific SOP for summary of Blank Limits
MDL : Determined annually
MDL Check Solution: Analyze after MDL study and quarterly. All analytes must be detected (qualitative test).
LDR: Determined initially, then LDR check verified every 6 months.

APPENDIX C, TABLE 10. QA/QC LIMITS FOR GFAAS - MOD. SW-846 METHOD 7010

Parameter (1)	Frequency	Acceptance Criteria/Comments	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB)	1/SDG	< 2*MDL or < 10% of lowest sample conc, whichever is greatest.	Re-digest/reanalyze all samples associated with PB.
Laboratory Matrix Spike (MS)	1/SDG	80-120% R N/A if sample conc. > 4*spike conc.	Flag/qualify samples as appropriate.
Matrix Spike Duplicate (MSD)	1/SDG	RPD ≤ 20%; 80-120% R for spike	Flag/qualify samples as appropriate.
Initial Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	1/10 samples	90-110% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Initial Calibration Blank (ICB)	After each ICV	+/- 3*MDL	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- 3*MDL	Recalibrate instrument and re-run all samples since last compliant CCB.
LLCCV (standard @ RLs)	After calibration	80 - 120% R	Recalibrate instrument
Analytical Spike (A)	every sample	85-115% R N/A if sample conc. > 4*spike conc.	Perform serial dilution – if RPD>10%, then perform Method of Standard Additions (MSA).
Serial Dilution (L) – 5X	As needed	RPD ≤ 10%	>10% RPD, perform MSA. Only required if A-Spike fails.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of 3 levels plus a blank. Method requires 2 integrations with RPD < 10%. Lowest calibration standard should be at the reporting limit.

NOTES: (1) Where 2 parameters are shown, the first applies to digested samples, and the second to non-digested samples.
SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.
See method specific SOP for summary of Blank Limits

APPENDIX C, TABLE 11. QA/QC LIMITS FOR CVAAS – MOD. SW-846 METHOD 7470A/71B

Parameter (1)	Frequency	Acceptance Criteria/Comments	Corrective Action
Laboratory Control Sample (LCS)	1/SDG	80-120% R for water Manufacturer's limits for soil	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB)	1/SDG	+/- 0.2 µg/L	Re-digest/reanalyze all samples associated with PB.
Laboratory Matrix Spike (MS)	1/SDG	No criteria specified – Laboratory criteria is 75-125% R if sample conc. < 4*spike	Flag/qualify samples as appropriate.
Matrix Spike Duplicate (MSD	1/SDG	No criteria specified – Laboratory criteria is ≤ 20% RPD (if sample conc > 10* MDL)	Flag/qualify samples as appropriate.
Initial Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	1/10 samples	80-120% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Initial Calibration Blank (ICB)	After each ICV	+/- 0.1 µg/L	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- 0.1 µg/L	Recalibrate instrument and re-run all samples since last compliant CCB.
LLCCV (0.1 µg/L)	After calibration	80 - 120% R	Recalibrate instrument
Analytical Spike (A)	1/SDG	85-115% R (spike conc. = 2-5 times sample conc.)	Only necessary if all samples in batch are < 2.5 µg/L. If %R not within 85-115%, do Method of Standard Additions.
Dilution Test (L)		+/- 10% if conc. in sample > 2.5 µg/L	If all conc. <2.5 µg/L, perform "A" spike. Only needed if MS, MSD, A-spike fail.
INSTRUMENT CALIBRATION REQUIREMENT: Minimum of 3 levels plus a blank			
NOTES: (1) Where 2 parameters are shown, the first applies to digested samples, and the second to non-digested samples. SDG = Sample Delivery Group (maximum size = 20 samples). R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained. See method specific SOP for summary of Blank Limits			

APPENDIX C, TABLE 12. QA/QC LIMITS FOR ICP-MS – MOD. SW-846 METHOD 6020A

Parameter (1)	Frequency	Acceptance Criteria/Comments	Corrective Action
Internal Standards	Each sample	80-120% R for ICV & CCVs; 30-120% R for samples	Dilute sample until internal standards fall within criteria
Laboratory Control Sample (LCS)	1/SDG	No criteria specified in method – Laboratory criteria is 80-120% R.	Re-digest/reanalyze all samples associated with LCS.
Preparation Blank (PB)	1/SDG	No criteria specified – Laboratory criteria is +/- 3*MDL	Re-digest/reanalyze all samples associated with PB.
Laboratory Matrix Spike (MS)	1/SDG	75-125% R N/A if sample conc. > 4*spike conc.	Dilute and re-analyze. Flag/qualify samples as appropriate.
Laboratory Matrix Spike Duplicate (MSD)	1/SDG	≤20% RPD for sample conc. > 100 * MDL	Dilute and re-run – RPD must be +/- 10%. If not, investigate/identify source of interference, rerun samples if appropriate.
Instrument Calibration Verification (ICV)	After each calibration	90-110% R	Recalibrate instrument.
Continuing Calibration Verification (CCV)	1/10 samples	90-110% R	Recalibrate instrument and re-run all samples since last compliant CCV.
Instrument Calibration Blank (ICB)	After each ICV	+/- 3*MDL	Recalibrate instrument.
Continuing Calibration Blank (CCB)	1/10 samples (after each CCV)	+/- 3*MDL	Recalibrate instrument and re-run all samples since last compliant CCB.
Interference Check Solution A (ICSA)	Beginning of run, every 12 hours	No criteria specified – Laboratory criteria is 80-120% R	Recalibrate instrument, re-run samples.
Interference Check Solution B (ICSAB)	Beginning of run, every 12 hours	No criteria specified – Laboratory criteria is 80-120% R	Recalibrate instrument and re-run all samples since last compliant interference check.
LLCCV	After each calibration	+/- 20%	Recalibrate instrument
Post-Digestion Spike (A)	1/SDG	75-125% R	Correct problem and re-analyze affected samples.
Serial Dilution (L)	1/SDG	+/- 10% of original conc. N/A if conc. < 100*MDL	Flag/qualify samples as appropriate.

INSTRUMENT CALIBRATION REQUIREMENT: Minimum of a blank and one standard. Must analyze tuning with at least 4 integrations and concentration RSDs less than 5% during pre-calibration sequence. Use 3 integrations for calibration & sample analysis.

NOTES

SDG = Sample Delivery Group (maximum size = 20 samples).
R denotes recovery, e.g. R of 90% denotes 90% of expected result was obtained.
See method specific SOP for summary of Blank Limits.

APPENDIX D

Bacteriological QA/QC Requirements

Bacteriological QA/QC Requirements

Daily or As Applicable

1. Calibrate pH meter each day used with 2 (pH 4 and 7) buffers.
2. Date reagents and chemicals at time of receipt and opening.
3. Date all solutions with date prepared.
4. Autoclave all incubated tubes and plates with growth for 30 minutes before discarding.
5. Select one random sterilized sample bottle from each autoclave batch and confirm sterility by adding approximately 20 ml of TSB and incubating at 35°C+/-0.5°C for 24 hours and check for growth. If growth is present, corrective action must be taken and retesting must be accomplished.
6. Check each batch of media for sterility by incubating 24 hours; check pH after incubation and record.
7. Check each batch of dilution/rinse water for sterility by adding 50 ml of autoclaved water to 50 ml of 2xTSB; incubate at 35°C+/-0.5°C for 24 hours and check for growth. Record sterility on autoclave chart.
8. Use Steri-strips or tape in every autoclave load. List all runs on the autoclave chart, recording date, load, length of run.
9. Date all prepared media with pull date and discard when too old.
10. Check sterilized pipets by filling and emptying into a sterile TSB tube; incubate the tube for 24 hours at 35°C+/-0.5°C and check for growth.
11. Balances are checked weekly with weights of 50, 5, 1, 0.1 and 0.05. The 0.1 and 0.05g weights are checked by adding to the 50g weight.

Monthly

1. Check de-ionized water for conductance, pH, chlorine residual and heterotrophic plate count.

LABORATORY PURE WATER REQUIREMENTS
pH = 5.5 - 7.5
Specific Conductance = <0.2 micromhos/cm
Total Chlorine Residual = 0.0
Heterotrophic Plate Count = <500/ml

Corrective action taken when outside above limits

2. Check dishwashing pH change after 24 hours. If pH changes by more than 0.2, then corrective action must be taken and pH retested until change is within 0.2.
3. A culture of Bacillus stearothermophilus (BBL Kilit Ampules #12018) is run monthly in autoclave along with the maximum recording thermometer. Results are recorded on the autoclave sheet.
4. When there is more than one analyst, analysts will count the same plate with sheen colonies and set up a duplicate testing where 2 technicians set up 50 ml of the same sample and compare results. Results of both duplicate count and duplicate testing should be within 10% of each other.
5. The conductivity meter is calibrated with 0.01 M KCl.

Quarterly

1. The autoclave timer is checked with a stopwatch/timer to make sure the autoclave cycles are accurate.
2. Media in disposable test-tubes are checked for evaporation after 2 weeks. must be under 0.5 ml/10 tube. If evaporation is in excess of 0.5 ml then the pull date will be changed from 2 weeks to 1 week.
3. Check MPN tubes to make sure they contain 10+/-0.5ml of media.
4. Check for alkaline or acid residual on glassware as follows:
   a. Choose a sample container (i.e. beaker) that has been washed and rinsed according to routine procedure. (Wash, 6 tap water rinses and 3 de-ionized water rinses.)
   b. Add de-ionized water to container and check pH of water.
   c. Let set for 24-48 hours.
   d. Recheck pH of water.
   e. Changes in pH over 0.2 indicate a residual on the glassware and the cleaning procedure must be checked and pH pre-tested until the pH remains within 0.2.

Annual

1. Denver balance is on an annual service contract with QC Services.
2. De-ionized water will be analyzed for bactericidal properties by a Laboratory approved by MDHES.
3. De-ionized water additionally will be analyzed for trace metals (Pb, Cd, Cu, Ni, and Zn). A single metal not greater than 0.05 mg/l and total metal </= 0.1 mg/l is acceptable.
4. Incubator and refrigerator thermometers are checked against the certified thermometer. The thermometers are tagged with the date for the check and any corrections.
5. A detergent suitability test is run on all detergents as follows:
   a. Wash and rinse 3 petri dishes in usual manner, 6 tap and 3 de-ionized rinses.
   b. Rinse 3 petri dishes in 6 rinses of de-ionized water.
   c. Wash some with detergent wash water (in use concentration) and drain dry without rinsing.
   d. Sterilize all three groups.
   e. Pour triplicate plates with same sample (20-60 colonies/plate) for each of 1.2. and 3 above and incubate as usual.
   f. If plates are rinsed (3) show a lowered count (15% or more) the detergent contains bacteriostatic substance and another detergent should be selected.
   g. If plates in group 1 show a lowered count (15% or more), toxic residues are left on glassware during routine washing procedure and a nontoxic detergent must be substituted for the one in use.

APPENDIX E

MSE Laboratory QA/QC System Audit

MSE LABORATORY QA/QC SYSTEM AUDIT

Performed By:______________ Date of Audit:__________________

Copies To: ______________________________

____

____

The purpose of this audit is to verify the quality of analyses performed by the Laboratory.

I.	**Sample Control**	**Yes**	**No**	**N/A**
1.	Is the refrigerator temperature monitored and recorded daily?	___	___	___
2.	Test and analytical samples are properly labeled?	___	___	___
3.	Is the Sample Logbook correct and up to date?	___	___	___
4.	Are samples stored in the refrigerator in an orderly fashion?	___	___	___
5.	Are samples disposed of or returned to the client according to schedule?	___	___	___
6.	Is the physical condition of incoming test samples being monitored?	___	___	___
7.	Are instructions for sample preservation available?	___	___	___
8.	Are order for analytical services/chain-of-custody sheets signed?	___	___	___

COMMENTS

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II.	**Water/Digestion Laboratory**	**Yes**	**No**	**N/A**
1.	Is preventive maintenance performed and documented?	___	___	___
2.	Do specific instruments have repeated maintenance problems?	___	___	___
3.	Are the instrument logbooks up to date?	___	___	___
4.	Are standards traceable to a nationally certified source?	___	___	___
5.	Are standards properly prepared and stored?	___	___	___
6.	Is the temperature of the drying oven recorded daily?	___	___	___
7.	Are "S" class weights used to check calibration of analytical balances?	___	___	___
8.	Is a record of yearly service available for analytical balances?	___	___	___
9.	Is the conductivity of the de-ionized water supply checked daily?	___	___	___
10.	Are the pH meters checked daily, or before use, and recorded?	___	___	___
11.	Are test procedures readily available to the analyst?	___	___	___
12.	Are QA documents available to the analyst?	___	___	___
13.	Are records available indicating analysis of duplicates and spikes?	___	___	___
14.	Are methods available for analysis of routine and non-routine samples?	___	___	___
15.	Are glassware-washing instructions posted?	___	___	___

COMMENTS

III.	**Instruments**	**Yes**	**No**	**N/A**
1.	Is preventive maintenance performed and documented?	___	___	___
2.	Has the operator performed control checks during the analytical procedure?	___	___	___
3.	Do specific instruments have repeated maintenance problems?	___	___	___
4.	Are the instrument logbooks up to date?	___	___	___
5.	Are standards traceable to a nationally certified source?	___	___	___
6.	Are standards properly prepared and stored?	___	___	___
7.	Are reference standards and calibration standards from different vendors?	___	___	___
8.	Are test procedures readily available to the analyst?	___	___	___
9.	Are QA documents available to the analyst?	___	___	___
10.	Are records available indicating analysis of duplicates and spikes?	___	___	___
11.	Are methods available for analysis of routine and non-routine samples?	___	___	___
12.	Are control charts used routinely for suspected or difficult method determinations?	___	___	___

COMMENTS

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IV.	**Sample Disposal**	**Yes**	**No**	**N/A**
1.	Are all samples evaluated for toxicity?	___	___	
2.	Are all drums labeled with appropriate labels (i.e., "Hazardous Waste")?	___	___	

COMMENTS

V.	**Documentation, Records and Training**	**Yes**	**No**	**N/A**
1.	Are all SOPs accurate, current, and accessible to all employees ?	___	___	___
2.	Are chemical and standard inventory accurate, (lot #, expiration date, etc) current, and accessible to all employees?	___	___	___
3.	Are training records available to indicate the status of individual training?	___	___	___
4.	Are all job descriptions current and accessible to employees?	___	___	___
5.	Does the Laboratory provide employees indoctrination and training in quality control?	___	___	___

COMMENTS

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VI.	**Quality Audits**	**Yes**	**No**	**N/A**
1.	Are audits performed on an announced, scheduled basis by qualified individuals?	___	___	___
2.	Are all areas of the Laboratory contributing to the quality of work audited?	___	___	___
3.	Are the results of the audit reported to management in writing?	___	___	___
4.	Are pre-audit and post audit conferences held for each audit?	___	___	___

COMMENTS

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ENERGY LABORATORIES-BILLINGS, MT

QUALITY ASSURANCE PROGRAM
FOR ALL FACILITIES LOCATED IN BILLINGS, MONTANA

Revision 2005.10

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President: William T. Brown — Date: 12/16/05

Vice President/Laboratory Director: John M. Standish — Date: 12/16/05

Corporate Quality Assurance Officer: Cornelius A. Valkenburg Ph.D. — Date: 12-16-05

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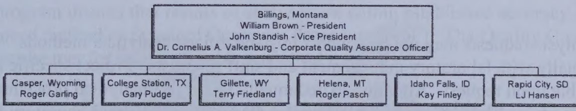
INTRODUCTION

Energy Laboratories, Inc. provides chemical, industrial hygiene, and environmental analytical services to private industry, agricultural industry, engineering consultants, government agencies, and private individuals. Analytical services include: analysis of waters and soils for inorganic and organic constituents, aquatic toxicity testing, hazardous waste analysis, radiochemistry, industrial hygiene, microbiology, soils and water physical parameters, and petroleum analysis. Founded in 1952, Energy Laboratories currently incorporates six separate testing laboratories. The main headquarters are located in Billings, MT, with branch laboratories located in Casper, WY, Gillette, WY, College Station, TX, Rapid City, SD, Idaho Falls, Id, and Helena, MT.

Figure 1
Laboratory Organization


Billings, Montana
William Brown - President
John Standish - Vice President
Dr. Cornelius A. Valkenburg - Corporate Quality Assurance Officer
Casper, Wyoming
Roger Garling
College Station, TX
Gary Pudge
Gillette, WY
Terry Friedland
Helena, MT
Roger Pasch
Idaho Falls, ID
Kay Finley
Rapid City, SD
LJ Hansen

The Quality Control Program establishes acceptable performance criteria for all routine analytical procedures being performed by laboratory personnel. The Quality Control Assessment program provides a formal system for evaluating the quality of data being generated and reported. The ELI Chemical Hygiene Plan insures the safety of all laboratory personnel and monitors the safety of all laboratory operations. These, in addition to the experience and expertise of our analysts, provide a comprehensive Quality Assurance Program. Energy Laboratories, Inc., in Billings, Montana, is certified under the Safe Drinking Water Act by Region VIII EPA for Wyoming, and the States of Montana, Idaho, Colorado, Nevada, North Dakota, and South Dakota. ELI-Billings also holds accreditation for Clean Water Act, Safe Drinking Water Act and RCRA parameters through the National Environmental Laboratory Accreditation Council (NELAC), which is supported by the EPA. This certification is maintained through the state of Florida and is carried in the states of Nevada, Colorado, and North Dakota. To perform Radon testing, ELI is certified under the National Radon Proficiency Program administered by the National Environmental Health Association. Branch Laboratories of ELI are certified in their own state and in neighboring states. Details on certification parameters for all laboratories are given in our Qualifications Manual and maintained on our website: http://energylab.com/

The ELI Quality Assurance Program Manual, the ELI Qualifications Manual, and the ELI Analytical Services Catalog together are used to outline the ELI Quality Assurance/Quality Control Program. This Quality Assurance Manual is appropriate to all departments of the Energy Laboratories-Billings. The procedures discussed or referenced in this manual describe our day-to-day laboratory practices and adhere to USEPA Safe Drinking Water Act and NELAC requirements and Good Laboratory Practices (GLPs). Information on ELI-Billings accreditations and certifications can be found in Appendix A of this plan. Where possible, ELI uses EPA, AOAC, ASTM, APHA, NIOSH, OSHA, or published analytical methods and follows the procedures with strict adherence to described protocol and recommended QA/QC parameters. Actual method operating procedures are described in the Standard Operating Procedures Manual, and are available for review at the laboratory. Vital parts of our Quality Assurance Program, quality control and quality assessment, are outlined in Chapters One and Two of this manual.

To generate data that will meet project specific requirements, it is necessary to define the type of decisions that will be made and identify the intended use of the data. Data Quality Objectives (DQOs) are an integrated set of specifications that define data quality requirements and the intended use of the data. Project specific DQOs must be established for both field and lab operations. Through the DQO process, appropriate reporting limits, extraction/digestion methods, clean-up methods, analyses methods, target analytes, method quality control samples, sample security requirements, quality control acceptance ranges, corrective action procedures, and reporting formats and reporting levels can be specified. Professional laboratory project managers are available to assist clients in specifying appropriate laboratory analyses and reporting procedures necessary to meet project requirements. Written Standard Operating Procedures referenced within this manual can be reviewed at our office upon request.

Certain types of analysis requests may not be suitable to standardized analytical methods. These custom requests are handled individually with laboratory management and staff scientists. Project specific methods and reporting packages are available upon request. Attention to documentation of the analytical procedure and use of suitable QC parameters is maintained according to good scientific discipline and Good Laboratory Practice guidelines.

This Quality Manual and related quality documentation meet requirements of the National Environmental Laboratory Accreditation Council (NELAC) and American Association of Laboratory Accreditation (A2LA) standards. These guidelines follow ISO 9000 and ISO 17025 guidelines.

CHAPTER 1 – QUALITY CONTROL PROGRAM

Objective

It is the policy of the management of Energy Laboratories, Inc. to produce laboratory data that is scientifically valid, meets method specifications, satisfies regulatory requirements, and accomplishes the data quality objectives of the client and project. Those method, regulatory, and client requirements are incorporated into our Quality Assurance Program. We will apply appropriate corporate resources to set objectives, provide training opportunities, and monitor the quality performance of our staff. We will also provide facilities and equipment adequate and appropriate to those objectives.

Purpose

The purpose of the Quality Assurance Program is to ensure that the analytical services provided by Energy Laboratories are of the highest quality, and each analytical result produced meets or exceeds a client's requirements and expectations. The quality systems in the program consist of the policies and procedures, and all referenced documents, described in this Quality Assurance Manual. The Quality Control Program also functions to maintain the laboratory's compliance with accreditations through USEPA, State Agencies, and NELAC. All employees are expected to implement and follow the policies contained within the Quality Assurance Program Manual. Internal documents, controlled and associated with the Quality Assurance Program are listed in Appendix B.

The Quality Control program insures that results of analyses are within established accuracy and precision limits required by the referenced method or Standard Operating Procedure (SOP). The Quality Control Program requires that the following points be met for each applicable analytical method:

Demonstration of Laboratory Capability

Performance of any analytical method requires that the proper equipment and instrumentation are available. A list of major equipment is listed in Chapter 12. The procedure for operation of an analytical instrument is described in the equipment manufacturers operating manual, and may also be supplemented with a specific Standard Operating Procedure (SOP) for the instrument and/or the method.

Each SOP covers operation of the instrument including the sequence of operations involved in instrument start-up, calibrating, analyzing, and shutting down. SOPs include recommended preventative maintenance, and/or a list of parameters used to identify other types of maintenance. The SOP also outlines any special safety precautions for operation of the instrument.

SOPs of well detailed EPA, ASTM, NIOSH, APHA, OSHA, or published procedures include, as appropriate, a list of any method specific items or variances, a list of QC parameters and their recommended performance ranges, recommended or example analytical sequences, specific or unique safety information, method references, and a signed signature page. Details and format of method SOPs follow NELAC requirements. Detailed SOPs are prepared for those procedures that do not have published methods.

Detailed information as to what information is required in method SOPs can be found in the ELI SOP 10-001-01.

Demonstration of Analyst's Ability to Generate Data of Acceptable Accuracy and Precision

ELI demonstrates that laboratory staff are qualified and capable of performing the method. Analysts are assigned duties based on their skills and experience. Training records are maintained for all analysts. Curricula vitae of supervisory and senior analysts are described in Appendix E.

It is the responsibility of the analyst to become thoroughly familiar with the methodology and instrument operation before performing the analysis. It is the responsibility of the person providing training to monitor all laboratory results generated for a reasonable time. The amount of time necessary may vary depending on the method and the experience of the analyst. As a minimum, the analyst's performance is to be monitored until the analyst demonstrates the ability to generate results of acceptable accuracy and precision according to the method.

All analysts are required to demonstrate and maintain a record of proof of competency by routinely analyzing quality control samples appropriate to the analytical procedures they perform. Competency in analyzing these control samples is documented in analysts' training files per NELAC requirements (for more information, see ELI SOP 10-005 on Personnel Training). For those analyses where external performance evaluation samples are not routinely analyzed, competency is documented by including the results of routine analyses of internal method quality control samples and/or a verifying statement of procedural review by a supervisor.

Analysis of Quality Control Samples

Each analytical method is subjected to quality control monitoring. The purpose is to demonstrate that results generated meet acceptable accuracy and precision criteria for the method. Quality control requirements are outlined in the methods and ELI at a minimum follows the guidelines specified in the methods used. Additional QC requirements are also added as appropriate. Statistical method performance is periodically evaluated against method requirements using control charts.

Quality control monitoring to measure accuracy for each method generally requires that five to ten percent of all samples analyzed be fortified (spiked) with a known concentration of target analytes tested by the method. Percent recovery is calculated. This provides a means for monitoring method accuracy and evaluating sample matrix effects. Where appropriate, surrogates are included in the method to monitor method performance on each individual sample. Blank spike samples replace matrix spike samples for certain methods, or when there is insufficient sample for a matrix spike analyses. Historical routine batch QC sample performance can be used to estimate the precision and accuracy of the method.

Quality control monitoring to measure precision for each method requires replicate samples be prepared and analyzed when possible. Actual requirements are outlined in the specific SOP. When replicate samples or matrix spike duplicates are analyzed, relative percent difference is calculated and used to monitor precision of the method. In instances where there are no specific method requirements, it is the policy of this laboratory to analyze five to ten percent of all samples in duplicate. Duplicate test results must be within the control limits established for each analysis type. Acceptance limits generally follow specifications listed in the method. Matrix spike duplicates replace sample duplicates for most methods.

When not defined in the method and as appropriate, method blanks and instrument blanks are analyzed one in every 20 samples at a minimum. Method blanks are used to verify that contamination from laboratory reagents and glassware is not present. The method blank must be less than the reporting limit, or 10 times less than the amount in the sample, for the analytical parameter being tested.

When not defined in the method, and as appropriate, method spikes (blank spikes) are analyzed one in every 20 samples at a minimum.

Calibration standards are analyzed and calibration curves developed for all applicable methods. For additional information on instrument calibration see Chapter 7 of this QA manual.

The initial calibration is continuously monitored by analyzing a continuing calibration standard every 10 to 20 samples, or within a specified time frequency, and at the end of each new set of samples, depending on the method and instrumentation. Results must be within an established range as described by the method SOP. As appropriate, initial calibrations are verified against a standard from a second source.

Performance evaluation samples and further quality control check samples may be required for various methods. Refer to Chapter Two of this QA manual for further details.

Maintenance of Performance Records

All quality control monitoring is recorded and documented. Quality control data is recorded in laboratory notebooks, electronic summary files, and/or analyses sheets. QC data can also be maintained in quality control forms, graphs, or charts. QC data management and control chart generation, maintenance, and usage are described in ELI SOP 20-004. It is the responsibility of the analyst to see that all results are recorded in a timely manner.

All quality control data is filed and available for inspection and assessment by analysts, supervisors, management, and quality control personnel.

Method Quality Control Specifications

Summary of Quality Assurance/Quality Control specifications for a selected subset of procedures offered by ELI are outlined in Appendix C. These tables are recommended for our clients to use in the preparation of Quality Assurance Project Plans (QAPPs). Exact details of method QC can be found in the applicable method SOPs.

CHAPTER 2 – QUALITY ASSESSMENT PROGRAM

Purpose

The function of the Quality Assessment Program is to provide formal evaluation of the quality of data being generated and reported by the laboratory. External and internal quality control measures are used in this assessment. These measures include performance evaluation samples, laboratory quality control check samples, and routine internal and external audits on methodology and documentation procedures.

Performance Evaluation (PE) Samples

PE samples are supplied by an outside entity and contain known amounts of constituents. The laboratory does not have access to known values of the samples. Only the PE provider has knowledge of constituent levels prior to the formal publishing of the test results.

These samples are received on a routine basis, with results sent to the providing entity for evaluation. Acceptable results are those which fall within a defined range as determined by the supplier. These study results are available for review upon request.

Performance Evaluation (PE) Samples for USEPA, NELAC and various State certifications are Water Pollution Study Samples (WP), Water Supply Study samples (WS) and NELAC SOIL PE samples provided by either Resource Technology Corporation (RTC) and/or Environmental Resource Associates (ERA), vendors accredited by the National Voluntary Laboratory Accreditation Program (NVLAP). Routine participation in NELAC, WS and WP PE sample studies is used to maintain certifications for Drinking Water, NPDES permit monitoring analyses, and projects requiring NELAC certification. These types of external PE samples are received on a semi-annual basis, with results sent to the reference supplier for evaluation. The samples are analyzed the same as any routine sample in the laboratory. Acceptable results are those which fall within a defined range as determined by the vendor/EPA/NELAC based on multi-laboratory study results. Results are sent by the provider to USEPA and other certifying agencies as requested by ELI-Billings. Note that our performance is substantially above the national average. Current study results are included in Appendix A. A current copy of the certificate to perform drinking water analyses in the State of Montana and the NELAC certificate is also included in Appendix A. The Montana certification includes a list of parameters for which drinking water certification has been granted. Reciprocal certifications to perform drinking water analysis in Wyoming, North Dakota, South Dakota, and Idaho, are based on the Montana certification. The NELAC certificate and list of parameters includes RECRA methods and methods associated with the Clean Water Act (NPDES permits).

Performance evaluation samples for Radon Proficiency testing certification are from the National Environmental Health Association (NEHA), an EPA approved commercial Radon testing certification association. Our own radon sampling canisters are submitted to NEHA for known levels of radon exposure. Acceptable results are those which fall within a defined ranged based on multi-laboratory study results.

Blind Quality Control Check Samples are samples submitted as regular lab samples and are processed through the system in the same manner as any other sample. The analysts do not know the true value when performing the analyses. Method performance reports are returned to the analysts and maintained in method performance files. Clients occasionally submit these types of samples for their QAPP.

Laboratory Inter-comparison Samples are samples containing known/unknown quantities of analytes that are split and analyzed by more than one laboratory. These samples are routinely analyzed and results are kept on file.

Quality Control Check Samples

Quality Control Check Samples - Are performance evaluation samples used for routine method performance monitoring. As appropriate, analytical procedures include the analysis of a quality control sample with every sample batch analyzed. The materials are obtained from a commercial source when available, or they may be prepared in-house. Acceptable results are within a defined range based on certified ranges, or, against statistically determined control limits. Routinely used methods not subjected to PE sample monitoring are evaluated with Quality Control Check Samples as appropriate.

QC samples are processed through the system in the same manner as any other sample, except the analyst is aware of the source, concentration, and acceptance ranges of target analytes and calculates analyte recoveries to evaluate method performance in real time.

Quality Control Audits

Quality Control Audits are internal and external laboratory analyses inspections designed to monitor adherence to quality control requirements. The audit checks general laboratory operations, overall Quality Systems, adherence to QA program requirements, sample tracking procedures, sample holding times, storage requirements, adherence to procedures during analysis, calculations, completion of required quality control samples within the group surrounding the sample, and proper record-keeping.

Internal quality control audits are conducted periodically by the quality control director of the laboratory (see ELI SOP 30-001 Internal Quality Assurance Audits). ELI conducts internal inspections on a regular basis to monitor adherence to quality control requirements. Results of formal audits are given to management with possible recommendations for corrective action in the event any discrepancies are found. As necessary, a follow-up review is conducted to determine that identified problems have been addressed. Annually, the overall Quality Systems of the laboratory are reviewed and a summary report is prepared. Laboratory management is involved with the annual review of laboratory Quality Systems.

External Quality Control Audits by qualified outside auditors are welcomed by ELI for outside review and comment on the overall QA program. To maintain certifications, accrediting authorities from the State of Montana, USEPA, and NELAC conduct periodic comprehensive external audits. External audits by private clients to meet Quality Assurance Project Plans (QAPPs), as applicable to environmental remediation projects, or for major industries, are also conducted on a continuing periodic basis.

CHAPTER 3 – LABORATORY FACILITIES

The facility for Energy Laboratories, Inc. – Billings, MT consists of 6 buildings, 5 of the buildings on the same city block with the main building address of 1120 South 27th Street, Billings, MT, 59107. The fifth building located at 405 South 24th Street, is used as overflow laboratory space and as warehouse storage. The phone number is (406) 252-6325, the fax number is 406-252-6069, the toll free number is 800-735-4489, and the email address is eli@energylab.com

Laboratory space includes adequate benchtop and floor space to accommodate periods of peak workloads. Working space includes sufficient benchtop area for processing samples; storage space for reagents, chemicals, glassware, bench and portable equipment items; floor space for stationary equipment; and adequate associated area for cleaning glassware. The laboratory contains at least 15 linear feet of usable bench space per analyst, and at least 150 to 200 square feet per person. Laboratory departments are organized and facilities designed for specific laboratory operations in order to protect the safety of analysts and to minimize potential sources of contamination between and within department areas (for more information see ELI SOP 10-002, Facility Description, Access, and Security).

The laboratory is appropriately ventilated and illuminated, relatively free of dust and drafts, and is not subject to excessive temperature changes. As required, laboratory areas are temperature and humidity controlled. A light intensity of 100-foot candles is present at all working surfaces. Ample cabinets, drawers and shelves are available for storage and protection of glassware. Exhaust and particulate filtering hoods are available as needed for use during preparation, extraction, and analysis of samples. Air quality monitoring is conducted routinely to ensure a safe working environment.

To maintain security, all non-ELI laboratory personnel and visitors must sign an ELI guest book and be escorted by a staff member of ELI when present in laboratory working areas. A secure sample log in area restricts the access of unauthorized personnel to other parts of the laboratory.

The laboratory has provisions for the disposal of chemical wastes and microbiological wastes. These provisions are described in Standard Operating Procedures and outlined in the Chemical Hygiene Plan along with other safety and health guidelines.

CHAPTER 4 – PERSONNEL REQUIREMENTS AND LABORATORY ORGANIZATION

Personnel Requirements

Laboratory Director

The Laboratory Director is required to have education equivalent to a Bachelor of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

Quality Assurance Officer

The Quality Assurance Officer is required to have a bachelors degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

Laboratory Supervisor

A Laboratory Supervisor is required to have education equivalent to a Bachelor of Science degree in Chemistry or related science. Two years of relevant laboratory experience is required.

Analysts

Analysts are required to have education equivalent to a Bachelor of Science degree in Chemistry or related science, or a High School diploma and 3 years experience as an analyst in training. A minimum of 6 months of on-the-job training, under direct supervision of qualified analyst in the measurements being considered for certification is also required. After 6 months, and on a continuing basis thereafter, the analyst must demonstrate acceptable skills through the successful participation in the analysis of applicable performance evaluation and quality control samples.

Laboratory experience can be substituted for academic requirements. For more information, see ELI SOP 10-004, Roles and Responsibilities.

Laboratory Organization

Corporate organization of the seven ELI laboratories located in Montana (2), Wyoming (2), Texas, Idaho, and South Dakota is shown in the Corporate Organizational Chart given in Appendix D. The Billings laboratory is the center for all corporate functions. Each laboratory is managed and operated individually under the supervision of a Laboratory director. Branch laboratory corporate responsibilities are only towards fiscal and general operating policies and goals. Quality Assurance Manuals are prepared individually for each branch and follow the QA/QC program outlined in the ELI-Billings QA manual.

The ELI-Billings Organizational Chart is also included in Appendix D with Curricula vitae of key ELI-Billings laboratory personnel maintained in Appendix E of this manual. Within the **Qualifications Manual**, detailed personnel summaries are given for all managers and supervisors of ELI, Inc. A Personnel Summary for all ELI employees listing title, academic background, and years of relevant experience is also maintained in the Qualifications Manual. Job descriptions can be found in the Roles and Responsibilities ELI SOP 10-004.

CHAPTER 5 – SAMPLING PROCEDURES

Most of the samples processed in this laboratory are collected by private individuals or companies who are responsible for using proper collection procedures. Members of the staff are acquainted with proper sample collection and handling procedures and will advise those who need help in this area. Instructions and forms for initiating Chain-of-Custody are available from ELI. Laboratory procedures for logging in samples for analyses and maintaining Chain-of-Custody are described in ELI SOP 20-001.

When the laboratory has been assigned the responsibility of sample collection, there is strict adherence to correct sampling protocols, initiation of Chain-of-Custody, sampling documentation, complete sample identification, and prompt transfer of sample(s) to the laboratory.

This laboratory will provide proper sample containers and preservatives as specified for the procedure. Certified sample bottles are available upon request. Sample containers, preservatives, coolers for shipping, ice packs for maintaining refrigeration temperature, travel blanks for monitoring contamination during shipping, temperature blanks for accurately monitoring sample receiving temperatures, Chain-of-Custody forms, Chain-of-Custody Seals, and sample bottle labels are provided upon request. Instructions for sampling, sample labeling, sample preservation, and sample packaging/shipping are also provided upon request. Sample container type, sample volume, preservation requirements, and maximum holding times, are detailed for each analyte in the ELI Analytical Services Catalog. See ELI website, http://energylab.com/ for current Analytical Services catalog. For metals analysis, polyethylene plastic with a polypropylene cap liner is preferred. Glass containers with Teflon-lined caps are required for most organic analysis. The client is immediately notified (if possible) upon sample receipt if samples are received in unacceptable containers, if samples have not been properly preserved, sample labeling or chain-of-custody procedures are incomplete, or if sample cannot be analyzed within method recommended holding time. Samples not collected or documented properly can be rejected for any regulatory-based analyses and re-sampling is recommended. If resampling is not possible, or the client cannot be contacted, the sample is analyzed, and the sample data is clearly qualified in the data package. The laboratory will preserve samples at the time of sample login if samples are unpreserved and preservation is required by the methodology. Aqueous samples for volatile analyses are checked for preservation at the time of analyses. Samples for microbiological analysis are collected in pre-sterilized 120 mL plastic bottles containing sodium thiosulfate.

Sample preservation needs to be performed immediately upon sample collection according to methodology. For composite samples, each aliquot must also be preserved at collection. When use of an automated sampler makes it impossible to preserve each aliquot, samples are preserved by maintaining at 4^{o} C until compositing and sample splitting is completed.

The laboratory initiates a sample condition report at the time of sample receipt. The sample condition report evaluates Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, cooler temperature, and provides general comments concerning sample condition. The sample condition report is provided with the sample analyses results data package. For more information, see ELI SOP 20-001, Sample Receipt, Login, and Labeling.

When any sample is shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements as described in the ELI Services Catalog, the Office of Hazardous Materials, Material Transportation Bureau, Department of Transportation has determined the Federal Hazardous Materials Regulations do not apply to the following:

A) Hydrochloric Acid - (HCl) in water solutions of 0.04% by weight or less (pH of 1.96 or greater).
B) Nitric Acid - (HNO_3) in water solutions of 0.15% by weight or less (pH of 1.62 or greater).
C) Sulfuric Acid - (H_2SO_4) in water solutions of 0.35% by weight or less (pH of 1.15 or greater).
D) Sodium Hydroxide - (NaOH) in water solutions of 0.080% by weight or less (pH of 12.30 or less).

It is required that all samples be analyzed within the prescribed holding times. Holding times are the maximum times allowed between sampling and analysis for results to still be considered valid. Samples should be delivered to the laboratory as soon as possible following collection to assure that holding times can be met. Samples are analyzed as soon as possible after sample receipt. When maximum holding times cannot be met, resampling is requested. Samples may be held for longer periods only if the permittee, or monitoring laboratory has data on file to show that the specific types of samples under study are stable for the longer time or if a variance is allowed. Some samples may not be stable for the maximum time period as given in the ELI Analytical Services Catalog. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability.

CHAPTER 6 – SAMPLE HANDLING

Sample Receipt

All samples arriving at the laboratory are recorded in the sample receipt log and each container is given a unique laboratory sample number.

Samples requiring preservation are checked to determine if the client performed preservation. If requested, ELI staff will preserve or filter samples as appropriate. Samples which degrade quickly, or cannot be opened (such as aqueous samples for volatiles), are not preserved at the time of sample login. If samples are improperly preserved, or the maximum holding times are exceeded upon arrival at the laboratory, the collector is notified and resampling is requested.

Chain-of-Custody forms are checked for pertinent information. If necessary information has been omitted, the collector is notified, if possible, and the missing information is requested.

Samples are stored in accordance with method specifications in designated laboratory areas.

During sample login, all sample information such as sample description, client name and address, analyses requested, special requirements, etc. are entered into the computer database of the Laboratory Information Management System (LIMS). Requested analyses parameters and special requirements are communicated to the analysts via their LIMS work lists. Project specific requirements are maintained in the LIMS for any samples received from a special project. This process ensures that individual requirements are maintained.

For more information, see ELI SOP 20-001, Sample Receipt, Login, and Labeling.

Chain-of-Custody

Evidence level internal Chain-of-Custody procedures are available on a project specific basis. For these procedures, internal COC sample custody is maintained down to the individual analyst level. When transferring the possession of the samples, the transferee must sign and record the date and time on the Chain-of-Custody record. Every person who takes custody must fill in the appropriate section of the Chain-of-Custody record. When received by ELI, sample identification information on the sample containers is compared to the custody report form. The sample is inspected and information regarding the condition of the sample and seal (if used) is recorded on a report form, the method of shipping is also documented on the report form. A copy of the report form is kept with the sample data file and a copy is sent to the client with the analysis report. Internal Chain-of-Custody forms are used to document the progress of the sample through the laboratory. For more information, see ELI SOP 30-005, Chain-of-Custody Samples.

ELI's routine COC policy is maintained at the laboratory level through our laboratory access and security policies. See ELI SOP 10-002, Facility Description, Access, and Security.

Sample Tracking

Samples are tracked through the analytical process by the LIMS. When all analyses are completed and approved by supervisory review, the data package is sent to the reporting department for final report generation. The completed report is sent to data validation and finally to invoicing at which point the report is mailed to the client. Generation of the invoice automatically changes the status of the samples in the LIMS to "Done" and removes them from the status report printed by the LIMS. Completed reports are reviewed by the Data Validators and sent to clients. See ELI SOP 20-002, Document Production, Control, and Archiving.

Sample Disposal

It is preferred that excess hazardous sample material be returned to the originator (client) for disposal by the originator. When this is not possible or reasonable, ELI will dispose of excess hazardous sample materials with hazardous waste generated in the laboratory. The disposal of all laboratory wastes will be performed in accordance with all local, state, and federal regulations, which apply to such activities. For specific information concerning a given waste, consult the appropriate SOP.

Subcontracting Policy

The ELI Billings laboratory utilizes the expanded branch laboratory capability and expertise to provide comprehensive analytical services. This occurs when the Billings laboratory is requested to perform an analysis they are not capable of doing, during the peak season when we experience sample overload, and when equipment is out of service. Upon completion of the analyses, the branch laboratories report the sample results and their quality assurance package to a Project Officer. The results are reviewed before being reported to our clients.

Other branch laboratories are certified to perform drinking water analyses in their state and in neighboring states. Samples are forwarded to our branch laboratories only if the laboratory is certified in the state from which the sample originated. The branch laboratories QA Program is consistent with the Billings QA Program and is monitored through internal laboratory audits. The following methods are routinely analyzed by branch laboratories to support ELI-Billings analytical services:

Total Organic Halogens (TOX) by SW-846 9020
Low level EDB and DBCP by EPA 504
Organohalide Pesticides and PCBs by EPA 505
Carbamates by EPA 531.1
Glyphosate by EPA 547
Diquat by EPA 549.1
Low level Total Organic Carbon (TOC)
Oil & Grease by SW-846 1664
All Radiochemistry except Radon

In the event that ELI is dependent on the service of an outside laboratory for analyses not available through our facility or our branch laboratories, the client will be notified in advance that their samples are being subcontracted to an outside laboratory. The outside laboratory reports the results to ELI and this becomes part of the final report. All final reports indicate where the analyses were performed.

CHAPTER 7 – INSTRUMENT OPERATION AND CALIBRATION

Laboratory instruments and equipment are operated and calibrated according to the manufacturer's instructions, and according to the requirements of the method being used. Exact calibration procedures are outlined in the appropriate SOP. For most instruments, a calibration curve composed of three to five standards covering the concentration range of the samples is prepared. Unless otherwise specified in the method, at least one of the standards is at or below the practical quantitation limit (PQL) of the method. Routine PQLs for each method are given in the **ELI Analytical Services Catalog**. Calibration standards are routinely compared against second source calibration standards to verify accuracy. The reference standard results must fall within an established range, as described by the SOP, to be accepted. Whenever possible, the laboratory uses calibration standards prepared from certified stock standards. Initial instrument calibration curves are verified and routinely monitored by running a continuing calibration standard every 10 to 20 samples, and at the end of every analytical sequence, depending on the analysis method and instrumentation. High-level samples, which produce an analytical response outside the calibrated range of the instrument, are diluted and reanalyzed such that a response within the calibrated range is obtained.

System cleanliness is verified through the analysis of reagent/instrument blanks prior to analysis, between highly contaminated samples, and at regular intervals during the analysis. Samples are only quantitated within the limits of the response of the standards.

Use of measuring equipment and reagents; glassware, water, chemical reagents, and industrial gases, conform to Good Laboratory Practice guidelines. Good Laboratory Practices (GLPs) are laboratory guidelines which were established by the Food and Drug Administration and published in the Federal Register (21 CFR, part 58) in the mid-1980's. The GLP guidelines were adopted by the Environmental Protection Agency. SOPs are developed in accordance with GLP and NELAC guidelines. Laboratory volumetric glassware conforms to National Institute of Standards and Technology (NIST) Class A standards. All mechanical pipetors are calibrated monthly. Laboratory balances are annually serviced and calibrated by certified technicians. Routine calibration checks of all balances are performed using NIST traceable Class S weights. Laboratory thermometers are annually calibrated against a NIST traceable thermometer, and routinely checked for accuracy. Laboratory drying ovens, incubators, freezers, refrigerators, and water bath temperatures are recorded each working day, or at frequencies as described in the specific SOP. Laboratory pure water is generated by commercial water purification systems and is monitored and documented each working day according to resistivity meter readings. The routine analyses of laboratory blanks is used to verify laboratory water quality and the suitability of sampling containers. Chemical reagents and gases exceed purity requirements for their intended uses. Laboratory stock and working standards are derived from commercially available primary standards whenever possible. Standards preparation notebooks document the source, purity, content, concentration, preparation date, and analyst. All calibrations standards are documented in the analytical sequence such that they are uniquely identifiable and traceable to stock standards and their source.

Standard Operating Procedures (SOPs) detail the sequence of operations involved in instrument start-up, calibration, analyzing, shutting down, and routine maintenance. Suggestions for corrective action are included with the SOPs and parameters are identified which dictate certain types of maintenance. Instrument and method detection limits are performed at the method required frequency or whenever there is a significant change in instrumentation. Detection limits are determined according to EPA guidelines found in 40 CFR, part 136, Appendix B. Acceptable instrument response/performance criteria are based upon the manufacturer's or the analytical method specifications. SOPs exist for all major pieces of analytical equipment/methods. Instrument maintenance logbooks are used to document instrument maintenance and repairs.

All instrumental run sequences are documented. Laboratory analysts record and document all instrumental runs in Laboratory Instrument Logbooks or computer files. Instrument Logbooks and/or dated computer files record instrument performance data, analytical sequences, instrument maintenance, calibration standards data, and any other additional information pertinent to operation of the instrument.

CHAPTER 8 - RECORDS AND REPORTING

Laboratory Notebooks

Several different types of Laboratory Notebooks are maintained at the ELI Laboratory. These include, but are not limited to, the following:

- Method/Parameter Notebooks
- Project Notebooks
- Instrument/Equipment Use and Maintenance Notebooks
- Standard Preparation Logbooks
- Sample Receipt Logbooks
- Safety Logbook
- Balance Calibration Logbooks
- Pipet Calibration Logbooks
- General Logbooks

The general purpose of maintaining each of these Laboratory Notebooks is to record the details which may be important in repeating a procedure, interpreting data, or documenting certain operations. Entries in the notebook may include data such as standard and sample weights, pH measurements, instrument operating parameters, preparation of calibration curves, analytical run sequences, calculations, recording of instrument operating parameters, sample condition, etc. The analyst's notebook is particularly important in documenting analyses which deviate in any way from routine or standard practices. It can also be an important training record. All pertinent data is to be recorded directly in the notebook. Some notebooks or data records are maintained in electronic files. Electronic data records are duplicated using hardcopy and/or alternate electronic backup techniques such as magnetic tape.

It is the responsibility of each analyst to maintain a laboratory notebook according to Good Laboratory Practices (GLP) Guidelines. Procedures for use and maintenance of laboratory notebooks are detailed in ELI SOP 20-010. All laboratory notebooks are assigned a unique logbook control # and are assigned to an analyst or supervisor. Laboratory Notebooks will remain the responsibility of the ELI staff member to whom they are assigned until, or unless, they are formally transferred to another staff member, until they are completely filled and returned to the ELI Quality Assurance Officer or ELI Laboratory Supervisor for archiving, or until the staff member resigns and returns them as a part of the check-out process. ELI staff members other than the individual to whom the Laboratory Notebook is issued may make entries in the Notebook as long as those entries are consistent with the intended use of the Notebook, and such entries are initialed. Laboratory Notebooks are the responsibility of each ELI staff member using the notebook. Supervisors review and approve all Laboratory Notebook formats.

Records

The laboratory for minimum of ten years keeps records of chemical analyses (beginning October 18, 2000), including all quality control records. In the event the laboratory transfers ownership or goes out of business, files will either be maintained, or first be offered to the client prior to their disposal. Details are described in ELI SOP 20-002, Document Production, Control, and Archiving.

Data Reduction

Data reduction refers to the process of converting raw data to reportable units. The reporting units used and analytical methods performed are described in the Analytical Services Catalog.

Wherever possible, the instrument is calibrated to read out directly in the units reported. In this case, the value is recorded directly into a laboratory notebook, logbook, bench sheet, or electronic file and presented for review by supervision.

In cases such as titration, gravimetric measurements, or other techniques that require calculation prior to reporting, raw data is recorded in the appropriate laboratory notebook or electronic file, or on the appropriate laboratory form. The calculations specified in the EPA method are used to determine the reported value. That value is also entered into the laboratory notebook or bench sheet, and on the draft of the client report. Most of the calculations are computerized to reduce the chance of arithmetic or transcription errors.

Wherever possible, electronic data results are transmitted throughout the laboratory via the LIMS computer network. This process is intended to minimize manual data transcriptions within the laboratory. Additional advantages include the opportunity for rapid comprehensive data validation by supervisors, and more rapid data reporting.

Validation

Data validation includes the procedures used to ensure that the reported values are consistent with the raw data, calculated values, sample type, sample history, and other analyses parameters requested.

The data recorded on the draft report is validated with several steps. The analyst who submits the report checks all the values reported for omissions and accuracy. Elements of this review also evaluate all instrument and method QC results. Automated data management programs are designed with an interactive step allowing data review by the analyst. Results to be reported are approved by the analyst.

The reported result and associated QC data is reviewed by the supervisor. Supervisors review the suitability of the data according to project and method performance specifications. Analyses results for each requested parameter are evaluated against other requested parameters, project specifications, other samples within the set, historical files associated with the project/client, and any other information provided with the sample. Supervisors initial all validated sample results.

The reports are generated, proofread, and then reviewed by the reporting staff.

The laboratory manager, or his/her designate, who also examines the validity of the data, reviews the final report.

Internal and external laboratory audits review selected sets of data to ensure that the analysis results are correct and accurate, analytical methods are appropriate, documentation and record keeping procedures complete, and that overall objectives of the Quality Assurance Program are adhered to.

All automated programs used to process and report data are verified using hand-calculated results. Whenever a modification is performed to a program re-verification of overall software function is performed.

Reporting

One copy of the report is mailed to the client on the day the report is completed and reviewed. A standardized report format is used unless otherwise specified. Individual states may have their own required reporting format. Client specified report formats are available upon request. Electronic results via diskette, email, website FTP, or FAX are available upon request. All electronic reporting is followed with a hardcopy of final results.

Various levels of data reporting are available. All analyses results, regardless of the level of reporting used, have record keeping procedures which allow a complete "data validation package" to be produced. Note that a comprehensive "data validation package" is most easily generated at the time of sample analyses. Example data packages are available upon request.

Safe Drinking Water Act (SDWA) compliance monitoring samples for microbiological and chemistry samples that exceed the SDWA maximum contaminant level (MCL) may require notification to the appropriate state agencies. This process is detailed in laboratory reporting ELI SOP 20-002. Generally, notification to the client, and to the state, of any SDWA MCL exceedence must be made immediately on the same day of analyses, or by noon the next business day.

If requested by the client, additional copies of the report will be sent to a specified address or person.

The final copy of a completed report is scanned and maintained as a graphics file. The electronic file of the report meets NELAC reporting requirements. An electronic copy of this file is available upon request.

For more information, see ELI SOP 20-002.

CHAPTER 9 - GENERAL LABORATORY PRACTICES

Chemicals and Reagents

When available and appropriate, chemicals used in the laboratory are analytical reagent grade (AR) chemicals purchased from reliable suppliers. Reagents are prepared, standardized, and made fresh as mandated by the method, their stability, and according to Good Laboratory Practices.

Stock or working standards are checked regularly for signs of deterioration, (e.g., discolorations, formation of precipitates) and are compared to independently prepared reference materials.

All standards and reagents are dated when received, opened, or prepared, and each are labeled with expiration dates.

Certified primary standards are obtained from commercial sources when available. Standards used for calibration are verified against second source standards whenever possible. Secondary and working standards are accurately prepared in volumetric flasks or other calibrated glassware from primary standards and stored in appropriate containers.

Titrants, standards, and other solutions used for analytical purposes frequently must be standardized upon preparation with certified or traceable standards. Method SOPs specify if standardization is necessary. The date and analyst's initials must be recorded on the container whenever re-standardized and records are maintained in a laboratory notebook.

Individual SOPs may also provide additional details for reagent requirements.

Reagent Interference

To determine the extent of reagent interference, method blanks are analyzed prior to sample analysis whenever appropriate.

If any interference cannot be eliminated, the magnitude of the interference is considered when calculating the concentration of the specific constituent in the sample, but only when permitted within the method being used.

If reagents, materials, or solvents contain substances that interfere with a particular determination, they are replaced.

Individual method SOPs may also provide additional requirements for handling reagent interferences.

Glassware Preparation

All glassware used for inorganic analyses is washed in warm detergent solution and thoroughly rinsed in tap water. Glassware is then rinsed well three times with deionized water. This cleaning procedure is sufficient for many analytical needs, but individual SOPs detail additional procedures when necessary. Glassware washing procedures for inorganic analyses are described in ELI SOP 30-001.

All glassware used for organic analyses is washed in warm synthetic detergent solution and thoroughly rinsed in tap water. The glassware is then rinsed well with deionized water, followed by rinses with acetone to remove any residual organics. Prior to use, the glassware is rinsed three times with the organic solvent to be used with the glassware. Glassware washing procedures for cleaning glassware for organic analyses are described in ELI-SOP-30-002.

All glassware used for microbiological analyses is washed in warm detergent solution. The detergent must be proven to contain no bacteriostatic or inhibiting substances. The glassware is rinsed thoroughly with suitable deionized water. Disposable pre-cleaned sterilized glassware is used wherever possible. Specific details are described in SOPs.

Disposable glassware/plasticware is preferred for many procedures in the laboratory. The cleanliness, and suitability of disposable glassware/plasticware is continuously evaluated for each test with the routine analyses of method blanks.

All volumetric glassware used in precise measurements of volume is class A, or laboratory calibrated.

Laboratory Pure Water

Distilled or deionized water is used in the laboratory for dilution, preparation of reagent solutions and final rinsing of glassware. For organic analyses, organic-free water is prepared and used. Deionized water is prepared to meet ASTM Type II specification for reagent water. Use and maintenance of laboratory reagent water systems are described in ELI SOP 30-005 and 30-007.

Water quality is monitored for acceptability in the procedure in which it is used. Specific details are listed in the appropriate SOPs.

Employee Training

All new ELI employees and contract personnel are given an initial general orientation and tour of the laboratory facilities. Personnel are shown the locations of safety equipment such as safety showers, eye wash fountains, fire extinguishers, and first aid supplies. Personal protective equipment such as lab coats, disposable gloves, and safety glasses (if applicable) are issued at this time.

Safety considerations are a vital part of the training process. All hazards associated with the performance of a procedure or with the operation of an instrument are to be understood by the trainee before training can be considered complete. General lab safety procedures are a part of the new and current employee training. Specific safety procedures are outlined in SOPs and in instrument Operator's Manuals. Training in use of protective clothing, eye protection, ventilation, and general safety are provided to each employee. Each employee is required to read the laboratory Chemical Hygiene Plan.

All new and existing employees must demonstrate capability prior to performing an analytical procedure independently (see Chapter 1). Method performance on Quality Control Samples is used to document employee training and work quality. Employees are required to read and sign the Quality Assurance Manual and all appropriate SOPs. Each employee also receives training on general laboratory policies including ethics and conflict of interest. ELI encourages attendance at courses, workshops and other forms of continuing education available from on-site seminars, private institutions, local schools, and State and Federal regulatory agencies. Staff and department meetings are held routinely to communicate company policies and procedures. All training on procedures and policies is documented per NELAC guidelines in employee training files. For more information see ELI SOP 10-005, Personnel Training.

Standard Operating Procedures

All routine laboratory operations and procedures are documented in Standard Operating Procedures (SOPs). SOPs are written to provide a reference that specifically defines requirements for routine procedures, so that consistent, safe, and efficient laboratory operations are possible. For analytical methods, SOPs generally provide information on the details of the analysis that is not specified in a published analytical method. For routine procedures other than analytical methods, SOPs define the steps required in accomplishing a given task. All SOPs are reviewed periodically to assure that they reflect any changes in laboratory operations. Method SOPs follow NELAC requirements. For more information on generation and distribution of SOPs, see ELI SOP 10-001, Preparation, Numbering, Use, and Revision of Standard Operating Procedures.

Client Confidentiality

Each employee has the responsibility to maintain confidentiality in all matters pertaining to our clients, samples submitted, and Energy Laboratories, Inc. Information obtained during employment with this laboratory regarding the specific business of this laboratory or its clients shall at no time be revealed to any outside sources without permission from the owner of the data.

CHAPTER 10 - QUALITY CONTROL MONITORING

Routine Monitoring

Temperatures of incubators, water baths, refrigerators, and ovens are checked and recorded according to a prescribed schedule.

All pH meters are calibrated against reference standards. Calibrations are noted in laboratory notebooks.

Conductivity of deionized water is continuously monitored.

Reagents are dated and initialed at the time of receipt; reagents are not used after recommended shelf life is exceeded.

Balances are checked daily against NIST traceable weights and are calibrated and serviced by certified technicians annually.

SOPs are reviewed periodically for correctness.

Laboratory Notebooks are reviewed periodically by supervisors for correctness and accuracy.

Performance Evaluation Samples are analyzed as required. (see Chapter Two of this QA Manual)

Quality Control Check Samples are analyzed with each analytical batch.

Internal and External audits are performed as specified or requested. (see Chapter Two of this QA Manual for additional discussion)

Additional monitoring requirements may also be specified in individual SOPs.

The Laboratory maintains an active fraud protection program that is implemented through the laboratory ethics policy. Additionally, the potential of fraud is monitored through analyst supervision, management supervision, regular internal audits, PT study participation, and an active quality assurance program.

Instruments/Methods

Calibration is performed as required by the analytical method or SOP. (see Chapter 7 of this QA Manual)

Depending on method requirements, the standard curve is verified with a known second source reference sample. The reference sample results must fall within the appropriate target range for the calibration to be accepted.

In most cases, the calibration is checked by running a continuing calibration standard every 10 to 20 samples, depending on the analysis and instrumentation. The verification standard results must fall within an established range as described by the SOP.

All laboratory instruments are subjected to preventive maintenance schedules. Preventive maintenance schedules are specified in instrument maintenance logbooks.

As appropriate, instrument and/or method detection limits are determined annually, or more frequently if changes in instrument performance are noted or per method requirements. Procedures for the determination of instrument detection and method detection limits are described in ELI SOP 30-009.

Precision and Accuracy requirements for each method are specified in the SOPs. General guidelines are given below.

> Each sample analyses batch will contain QC samples to measure the accuracy of the method. Each QC sample result is monitored to be within QC specifications of the method. Results of blank spiked sample analysis must be within the established control limits. Quality Control Limits are specified in the SOPs and meet recommended QC limits as described in the referenced method.
>
> Each sample analyses batch will contain QC samples to measure the precision of the method. (see chapter One for discussion on duplicate sample analyses.) Criteria for duplicate sample acceptance are found in the SOP, and are generally taken from the referenced method.
>
> Each sample analyses batch will contain QC samples to measure the performance of the method on the sample matrix. These are typically identified as a matrix spike analyses and are often done in duplicate to also measure precision. Typically the sample is fortified with a known amount of target analyte and spike recoveries are calculated. Results outside of method QC guidance are flagged. Quality control limits and appropriate corrective actions steps are specified in the method SOP.
>
> Several methods are considered to be concurrent methods in that they are either nearly identical or are identical to a method with a different citation. Even if two methodologies are identical in procedure, slight differences in the QC requirements might be the only difference between the two methodologies. These types of methods may also be considered "concurrent" if the procedures are identical and the more stringent of the two method criteria are used. During data reduction and reporting, the referenced method specifications and criteria will always take priority. The following methodology sets are considered concurrent methodologies: Methods 245.1, 7470A and SM3112B. Methods 200.7 and 6010B. Methods 200.8 and 6020. Methods 415.1 and SM5310B. Methods 415.2 and SM5310C. Other essentially procedurally equivalent methods may be combined into a common single analytical procedure as well.

As appropriate, the performance of QC samples results are evaluated with Quality Control Charts. Suitability of existing QC limits is evaluated and possibly adjusted, but not to exceed method specification.

CHAPTER 11 – CORRECTIVE ACTION

When the quality control checks indicate that an analysis is not within the established control limits, corrective action is needed. This section gives general guidelines for corrective action. Corrective actions for each method or instrument are detailed in individual SOPs.

Method QC such as continuing calibrations, instrument blanks, method blanks, duplicate, blank spike, matrix spike, or matrix spike duplicate samples which fail to fall within QC control limits are analyzed again to verify if a problem exists. If this repeat is not within control limits, the particular instrument or procedure is checked according to the specific protocols outlined in the method or according to the instrument manufacturer's guidelines. Once results are within control limits, analysis of all samples that were analyzed while the procedure was out of control are repeated, i.e., all analyses are repeated back to the previous acceptable control sample. If the analyst is unable to achieve acceptable results after following the corrective action guidelines detailed in the SOP, supervision is consulted. If necessary, the appropriate service personnel are contacted if the problem is determined to be due to instrument error, and cannot be resolved. In certain cases, where control limits are exceeded, it is possible that problems cannot be corrected to satisfy QC criteria. This could be due to problems such as matrix interference, instrument problems, lack of sufficient sample, missed holding times, high blank contamination, etc. If all possible solutions available to correct the problem are examined and the sample results are still considered valid, qualifying comments are attached to the sample report describing the non-compliance to QC and probable cause.

In the event that a QC audit or other informational review shows an analysis report to be incorrect, incomplete, or adversely compromised, a written corrected report and explanation is submitted to the client. As appropriate, an explanation submitted to the client should give a detailed review of the problem and document any unapproved deviations from the regulations, standard operating procedures, or project specific scope of work that may have caused it. The explanation to the client shall include but not be limited to the following components:

What actions have been taken regarding the affected data set(s).
Identification of the cause.
Corrective action taken to prevent future occurrence.

Procedure for Dealing with Complaints

Definition:

Complaint	For the purposes of this procedure, a complaint comes from a client or other user of our data. The complaint might cover issues about the quality of our data, turnaround, method used, pricing, or other expectations.
Client	The client is the person or company that ordered and paid for the services. This is the person that a sample is logged in or filed under.

Procedure:

The staff person receiving the complaint exercises judgment in deciding the severity and disposition of every complaint. The judgment must be used to decide whom, if anyone is alerted to the complaint and what actions are appropriate. The individual handling the complaint is instructed to follow ELI's guidelines on how to handle the complaint. This involves listening to the client and getting adequate information so the complaint can be investigated and resolved. The appropriate laboratory staff is notified and a solution to the problem and a timeline for action is given.

After the complaint is investigated or resolved, as necessary, the client is made aware of the results and determination is made as to what further actions are needed. Complaints and investigations may result in the need to submit a revised report or invoice. Complaints that are straightforward and can be resolved using the resources available to the person handling the complaint should be resolved there. These include such things as minor revisions of reports or invoices. If other decisions need to be made, the appropriate person should be contacted.

It may be appropriate to initiate or prepare a non-compliance report. This report should be completed with the intention of informing the affected staff about the problem so that we can all learn from it, change our procedures and improve our service. A procedure to document non-compliance reports is documented in ELI SOP 20-011.

Penalty for Improper, Unethical or Illegal Actions

Employees of Energy Laboratories, Inc. are expected to work in an ethical, proper, and legal manner. They are expected to perform laboratory analyses according to the cited method(s) and in conjunction with the SOP and the Quality Assurance Plan. Employees are expected and required to report any violations of this policy.

The penalty for improper, unethical, or illegal actions performed by an employee will be determined on a case-by-case basis. It will be set, in part, by the severity of the offense. A first time, minor offense may simply require instruction about the expectations of the company. A subsequent, willful, or more serious incident may require anything from supervisor reprimand to termination of employment. The supervisory staff and the laboratory director will determine the penalty. Consideration of such elements as employee experience, training, and attitude, and the seriousness of the problem will be used to set the penalty.

CHAPTER 12 - MAJOR EQUIPMENT AND METHODS

ENERGY LABORATORIES, INC – BILLINGS, MONTANA

Equipment	**Quantity**	**Methods**
Gas Chromatograph-FID with auto sampler	3	DRO, EPH (Mass. Method), TPH as Diesel
Gas Chromatograph-PID/FID with purge and trap and auto sampler	4	GRO, VPH (Mass. Method), TPH as Gasoline, 602, 8020
Gas Chromatograph-Dual ECD with auto sampler	2	504, 505, 508, 515, 608, 8081, 615, 8151
Gas Chromatograph-Mass Spectrometer with auto sampler	5	525, 507 mod., 625, 8270
Gas Chromatograph-Mass Spectrometer with purge and trap and auto sampler	4	524, 624, 8260
GPC cleanup apparatus	1	3640
Atomic Absorption Spectrophotometer with cold vapor apparatus	1	7470, 7471, 245.2
Inductively Coupled Argon Plasma Emission Spectrophotometer	2	200.7, 6010
Inductively Coupled Argon Plasma Spectrophotometer-Mass Spectrometer	2	200.8, 6020
Ion Chromatograph	2	300.0
Microscope, PCM, PLM	1	EPA 600/M4-82-020, RTI 600/R-93/116, NIOSH 7400, NIOSH 7402
Auto Titrator	2	310.0, SM 2320B
Flow Injection Analyzer	3	350.1, 353.2, 365.1, 420.2, 335.1, 335.3, 335.4, 415.2, ASTM D2036
Fix Wavelength IR Spectrophotometer	1	413.1, 418.1
UV-VIS Spectrophotometer	1	410.4, SM 3500-Cr, 376.2, SM4500, 420.1

CHAPTER 13 - PREVENTIVE MAINTENANCE

Preventive maintenance is performed on laboratory equipment according to the manufacturer's guidelines and our experience in its operation. An outline of the maintenance on our major equipment follows:

Instrument	**Maintenance**	**Frequency**
Balances	Check with Class S weights	Daily
	Independent Service	Annually
Pipettes	Check volume	Monthly/Daily
ICP-Atomic Emission	Check Pump Tubing	Daily
	Check Coolant Levels	Daily
	Lubricate Autosampler	Quarterly
	Air Filter	Quarterly
	Optics Servicing	Annually
ICP-Mass Spectrometry	Check Pump Tubing	Daily
	Check Coolant Levels	Daily
	Check Electron Multiplier	Monthly
	Lubricate Autosampler	Quarterly
	Air Filter	Quarterly
	Same as other Mass spectrometers	
Gas Chromatograph	Change Septum	As needed
	Check injection liner	Daily
	Clean detector	As needed
	Change gas cylinders	At 200 psi
	Change column	As needed
Auto Analyzers	Check bath temperature	Daily
	Check for leaks	Daily
	Change tubing	When wear is visible
	Align flow cell	Quarterly
	Lubricate pumps	Annually
	Lubricate sampler	Annually
Mass Spectrometers	Monitor vacuum pressures	Daily
	Monitor background levels	Daily
	Monitor electron multiplier	Daily
	Change pump oil	Annually
Aquatic Toxicology	Room temperature	Daily
	Aquarium temperatures	Daily
	Aquarium pH	Daily
	Aquarium water levels	Daily
	Aquarium water parameters	Daily
	Aquarium filters	Annually, or as specified
	Dechlorination filter	Quarterly
	Pump maintenance	Annually
Microbiology	Monitor room temperature	Twice daily
	Monitor Incubator Temperature	Twice daily
	Autoclave maintenance	Annually
	Monitor water bath temperature	Twice daily
Reagent Water Systems	Change/check cartridges	Quarterly, or as needed
Compressed Gases	Change gas cylinders	At 50 psi, monitor daily
Liquid Chromatograph	Flush system	Daily
	Change filters	As needed
	Change lamps	As needed
	Replace seals	As needed

CHAPTER 14 - REFERENCES

Handbook for Analytical Quality Control in Water and Wastewater Laboratories Environmental Protection Agency.

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA, 1998.

Methods for Chemical Analysis of Water and Wastes Environmental Protection Agency, 600/4-79-020.

Methods for the Determination of Metals in Environmental Samples – Supplement I, EPA/600/R-94-111, May 1994

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993.

Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1998.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement I, EPA/600/4-90/020, July 1990.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement II, EPA/600/R-92/129, August 1992.

Technical Notes on Drinking Water Methods, EPA/600/R-94/173, October 1994.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846), Environmental Protection Agency, Final Update III and IIIB, 1997 and 2005.

ASTM Annual Book of Standards, Part 31 (water). American Society for Testing and Materials.

Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Ed., EPA 815-R-05-004, 2005.

NELAC Chapter 5: Quality System Standard, 2003 or most current version approved by Florida NELAC Accreditation program.

Laboratory Services Catalog, Current Revision, Energy Laboratories, Inc.

Qualifications Manual, Current Revision, Energy Laboratories, Inc.

CHAPTER 15 - GLOSSARY OF TERMS

Accuracy - The degree of agreement between an observed value and an accepted reference value.

Analytical Sample - Any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank.

Audit - A systematic evaluation to determine the conformance to quantitative specifications of some operational function or activity.

Batch - Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to twenty environmental samples of the same matrix, meeting the criteria above. An analytical batch is composed of prepared environmental samples, extracts, digestates, or concentrates, which are analyzed together as a group and in a similar time frame.

Blind QC Check Samples - Samples whose analyte concentrations are not known to the analyst. That the sample is a QC check sample may or may not be known to the analyst.

Blank - An artificial sample designed to monitor the introduction of artifacts into the process. The blank is taken through the appropriate steps of the process.

Blank Spike - See Standard Matrix Spike.

Calibration - The set of operations which establish, under specified conditions, the relationship between values indicated by the measuring instrument and the corresponding known value of the property being measured.

Calibration Blank - A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

Calibration Check Standard - See Check Standard.

Calibration Curve - The mathematical relationship between the known values and the instrument responses for a series of calibration standards.

Calibration Standard - A solution of known concentration used in the calibration of an analytical instrument.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - The enabling legislation (42 USC 9601 - 9675 *et seq.*, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC 9601 *et seq.*), to eliminate the health and environmental threats posed by hazardous waste sites.

Check Standard - A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process.

Clean Water Act - Public Law PL 92-500. Found at 40 CFR 100-140 and 400-470. The act regulates the discharge of pollutants into surface waters.

Continuing Calibration Standard - See Check Standard.

Continuing Calibration Verification - See Check Standard.

Control Limits - A range within which specified measurement results must fall to be compliant.

Control Standard - See Check Standard.

Corrective Action - An action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

Data Quality Objectives - An integrated set of specifications that define data quality requirements and the intended use of the data.

Duplicate - A second aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Duplicate Sample - See Duplicate.

Fortified Sample - See Sample Matrix Spike.

Initial Calibration Verification - A sample of known concentration, from a source other than that of the calibration standards, analyzed following calibration to demonstrate validity of the calibration.

Instrument Blank - See Calibration Blank.

Laboratory Intercomparison Sample - A performance evaluation sample analyzed by numerous laboratories. Acceptance criteria are often based statistically on the analysis results.

LIMS - Laboratory Information Management System.

Matrix Spike/Matrix Spike Duplicate - See Sample Matrix Spike or Sample Matrix Spike Duplicate.

Method Blank - A clean sample processed simultaneously with, and under the same conditions as, samples containing an analyte of interest through all steps of the analytical procedure.

Method Detection Limit - A measure of the limit of detection for an analytical method determined according to the procedure given in 40 CFR Part 136 Appendix B.

MCL-Maximum Contaminant Level. Regulatory action levels for a contaminant of concern.

NELAC - National Environmental Laboratory Accreditation Council.

NELAP - National Environmental Laboratory Accreditation Program.

National Pollutant Discharge Elimination System (NPDES) - A discharge permit system authorized under the Clean Water Act.

Performance Evaluation (PE) Sample - A sample with a composition unknown to the analyst, which is provided to test whether the analyst/laboratory can produce analytical results with specified limits.

Precision - The degree to which a set of observations or measurements of the same property conform to themselves.

Preservation - Refrigeration and/or reagents added at the time of sample collection to maintain the chemical and/or biological integrity of the sample.

Quality Assurance Project Plan (QAPP) - A formal document describing the detailed quality control procedures pertaining to a specific project. For environmental clean-up projects this is typically produced by an engineering firm with references to include a laboratories Quality Assurance Program Manual.

Replicate - An additional aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Reporting Limit (RL) – Also known as the Practical Quantitation Limit (PQL). The lowest level of reportable concentration for the method and the analyte.

Resource Conservation and Recovery Act (RCRA) - The enabling legislation under 42 USC 321 *et seq.* (1976) that gives EPA the authority to control hazardous waste.

Safe Drinking Water Act (SDWA) - The enabling legislation, 42 USC 300f *et seq*. (1974), which requires the USEPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sample - A portion of material to be analyzed.

Sample Matrix Spike - An aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the methods recovery efficiency.

Sample Matrix Spike Duplicate - A second aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the methods recovery efficiency and the precision of the method.

Spiked Sample - See Sample Matrix Spike.

Standardization - See Calibration.

Standard Matrix Spike - An aliquot of blank matrix to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the method's recovery efficiency.

Standard Operating Procedure - A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

Trip Blank - One type of Field Blank. An aliquot of analyte-free water or solvent transported to the field in a sealed container and returned to the laboratory with the sample containers.

APPENDIX E

DEQ LETTER
GROUNDWATER MONITORING STATISTICS

Montana Department of
ENVIRONMENTAL QUALITY

Marc Racicot, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • E-mail: www.deq.state.mt.us

April 17, 2000

RECEIVED
APR 19 2000

James E. Johnston
Public Works Director
Butte-Silver Bow Public Works
Courthouse
Butte, Montana 59701

RE: GROUND WATER MONITORING – STATISTICS

Dear Mr. Johnston:

Enclosed is a copy of the technical paper by Robert D. Gibbons detailing the statistical methodology to which I had referred in my letter dated February 7, 2000. I hope you and/or at least one of your technical representatives were able to attend the Solid Waste Management Facility Monitoring Requirements seminar in Missoula on March 27 and 28, 2000. This prediction interval approach to statistics was presented at the seminar by Tim Stepp with the DEQ. A copy of his slide presentation is enclosed. Should there still be some uncertainty as to how to apply this type of statistical comparison, here is a hypothetical example.

Sample dates	F/96	S/97	F/97	S/98	F/98	S/99	F/2000	S/2000	F/2000
Constituent #1 concentrations	10	10	5	8	9	8	10	9	12

... Six to eight data points needed for historical baseline.

In this example, the fall 2000 sample of 12 is above the concentrations in the baseline data. At this point, the facility has two options: 1) begin assessment monitoring, or 2) re-sample. If the concentration in the re-sample is:

- less than or equal to 10, the facility can continue in detection monitoring; or
- greater than 10, the facility must begin assessment monitoring.

One factor under consideration at this time is how broadly this methodology will apply to the Table 1 (ARM 17.50.708) list of detection monitoring parameters. Most assuredly, it will be applicable to metals analytical data (including arsenic and cyanide). Initial detection of VOCs prompts a re-sample and/or assessment monitoring. This methodology may be most valuable as a quick-look for facilities themselves in evaluating changes/increases in indicator parameters such as specific conductivity, chloride, sulfate, possibly pH, and potentially, for nitrates (if not over the MCL).

This is a very straight forward statistical methodology that does not require calculations, a computer program, or a consultant to figure it out. However, should re-sampling become excessive, such as in the case of seasonality, the facility may want to use a different statistical methodology. At the new Butte-Silver Bow Class II Landfill, there appears to be little change in the data values from the historical baseline concentrations. Therefore, the non-parametric prediction interval method appears to be an appropriate, cost-effective statistical evaluation tool for the Class II facility.

I can be contacted at the Permitting and Compliance Division, Community Services Bureau, Waste Management Section, phone (406)444-0538.

Sincerely,

Pat Potts

Pat Potts –Environmental Specialist
Solid Waste Regulatory Program

cc: Shawn Bisch, Pioneer Technical Services. P.O. Box 3445, Butte, MT 59702
Gary Keeler. Butte-Silver Bow
Dan Powers, R.S.

A General Statistical Procedure for Ground-Water Detection Monitoring at Waste Disposal Facilities

by Robert D. Gibbons[a]

Abstract

Nonparametric upper prediction limits for ground-water detection monitoring are developed. The limit is defined as the maximum of a previous background sample of size n (i.e., $X_{(max,n)}$). The probability that at least one out of the next m measurements (i.e., $Y_{(min,m)}$) will be less than $X_{(max,n)}$ at each of k monitoring wells is computed. In the context of ground-water monitoring, m is equal to the initial new measurement in a particular monitoring well plus m − 1 resamplings of that well. In this way, values of n and m can be selected to assure a desired confidence level (e.g., $\gamma \geq .95$). A series of typical examples are described, and a set of Tables that give these probabilities for values of n = 4 to 100, k = 1 to 100, and m = 1 to 3 are provided. Generalization to multiple variables (i.e., indicator parameters) is also discussed.

1. Introduction

There has been considerable controversy over the appropriate statistical methodology for evaluating the impact of waste disposal facilities on ground-water quality. Typically, comparisons are made between a set of historical upgradient background measurements and an individual new monitoring measurement, separately in each of a series of downgradient wells. A single comparison that results in statistical significance at the 5% level is taken as evidence that the facility is impacting ground water, regardless of the number of comparisons made. An additional complication is introduced by the fact that several commonly used variables (i.e., indicator parameters) have markedly non-normal distributions, that are often resistant to simple data transformation. Furthermore, these distributions are often censored, in the sense that a proportion of the observations are measured below an established method detection limit. For volatile organic priority pollutant compounds, which are commonly used indicators of contamination, the proportion of nondetected values is often in excess of 95%, ruling out the application of traditional statistical methods.

Some attempts at a solution to these problems have been proposed by Gibbons (1987a and 1987b), Davis and McNichols (1987), and McNichols and Davis (1988) by providing prediction limits for future measurements at each of k monitoring wells based on a previous sample of n background measurements. Gibbons (1987a) has suggested solutions to the normal, log-normal, and censored log-normal cases, and Gibbons (1987b) developed both prediction and tolerance regions for the Poisson distribution. Davis and McNichols (1987) extended the work for the normal distribution to include the effects of resampling once a significant difference is detected. Statistical procedures for paired-well comparisons and intrawell comparisons also have been considered by Loftis *et al.* (1987), Harris *et al.* (1987), and Montgomery *et al.* (1987). Statistical prediction and tolerance intervals are now recommended for both detection and compliance monitoring of hazardous waste disposal facilities by the new USEPA statistical regulation (USEPA, 1988).

In this paper, a nonparametric approach to constructing prediction limits is described. Specifically, interest is in the probability that at least one of m future measurements in each of k monitoring wells will not exceed the maximum of n previous samples. For example, consider a hypothetical facility with two upgradient wells and five downgradient wells for which quarterly monitoring produces relatively independent ground-water measurements. In terms of the upgradient wells, two years of quarterly monitoring have taken place yielding 16 background measurements. Using calculations to be described and assuming that (1) the distribution of the indicator parameter is continuous, (2) the distribution of water quality is the same in background and monitoring locations, and (3) the measurements are independent, the probability that the five new monitoring values (i.e., one at each of the five downgradient wells) will be less than the maximum of the 16 background measurements is .762. Clearly, this decision rule does not have a reasonable false positive rate (i.e., 1 − .762 = .238). However, assume that in the 23.8% of the cases in which a false positive result is obtained, the owner/operator is permitted to resample the well and if the new measurement is below the maximum of the 16 background values, the facility could return to normal detection monitoring. With a single resampling, we are now interested in the probability that at least one out of two measurements at each of the five monitoring wells will be less than the maximum of the 16 background measurements. This probability is given in Table 2 as .968 or a false positive rate of only 3.2%. This

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[a] Associate Professor of Biostatistics, University of Illinois at Chicago, ISPI, 1601 W. Taylor, Chicago, Illinois 60612-4397.

Received November 1988, revised April 1989, accepted May 1989.

Discussion open until September 1, 1990

Table 1. Probability That a Single Sample Will Be Below the Maximum of n Background Measurements at Each of k Monitoring Wells

Previous	Number of Monitoring Wells (k)														
n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	.800	.667	.571	.500	.444	.400	.364	.333	.308	.286	.267	.250	.235	.222	.211
5	.833	.714	.625	.556	.500	.455	.417	.385	.357	.333	.312	.294	.278	.263	.250
6	.857	.750	.667	.600	.545	.500	.462	.429	.400	.375	.353	.333	.316	.300	.286
7	.875	.778	.700	.636	.583	.538	.500	.467	.437	.412	.389	.368	.350	.333	.318
8	.889	.800	.727	.667	.615	.571	.533	.500	.471	.444	.421	.400	.381	.364	.348
9	.900	.818	.750	.692	.643	.600	.562	.529	.500	.474	.450	.429	.409	.391	.375
10	.909	.833	.769	.714	.667	.625	.588	.556	.526	.500	.476	.455	.435	.417	.400
11	.917	.846	.786	.733	.687	.647	.611	.579	.550	.524	.500	.478	.458	.440	.423
12	.923	.857	.800	.750	.706	.667	.632	.600	.571	.545	.522	.500	.480	.462	.444
13	.929	.867	.812	.765	.722	.684	.650	.619	.591	.565	.542	.520	.500	.481	.464
14	.933	.875	.824	.778	.737	.700	.667	.636	.609	.583	.560	.538	.519	.500	.483
15	.937	.882	.833	.789	.750	.714	.682	.652	.625	.600	.577	.556	.536	.517	.500
16	.941	.889	.842	.800	.762	.727	.696	.667	.640	.615	.593	.571	.552	.533	.516
17	.944	.895	.850	.810	.773	.739	.708	.680	.654	.630	.607	.586	.567	.548	.531
18	.947	.900	.857	.818	.783	.750	.720	.692	.667	.643	.621	.600	.581	.562	.545
19	.950	.905	.864	.826	.792	.760	.731	.704	.679	.655	.633	.613	.594	.576	.559
20	.952	.909	.870	.833	.800	.769	.741	.714	.690	.667	.645	.625	.606	.588	.571
25	.962	.926	.893	.862	.833	.806	.781	.758	.735	.714	.694	.676	.658	.641	.625
30	.968	.937	.909	.882	.857	.833	.811	.789	.769	.750	.732	.714	.698	.682	.667
35	.972	.946	.921	.897	.875	.854	.833	.814	.795	.778	.761	.745	.729	.714	.700
40	.976	.952	.930	.909	.889	.870	.851	.833	.816	.800	.784	.769	.755	.741	.727
45	.978	.957	.937	.918	.900	.882	.865	.849	.833	.818	.804	.789	.776	.763	.750
50	.980	.962	.943	.926	.909	.893	.877	.862	.847	.833	.820	.806	.794	.781	.769
60	.984	.968	.952	.937	.923	.909	.896	.882	.870	.857	.845	.833	.822	.811	.800
70	.986	.972	.959	.946	.933	.921	.909	.897	.886	.875	.864	.854	.843	.833	.824
80	.988	.976	.964	.952	.941	.930	.920	.909	.899	.889	.879	.870	.860	.851	.842
90	.989	.978	.968	.957	.947	.937	.928	.918	.909	.900	.891	.882	.874	.865	.857
100	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870

Previous	Number of Monitoring Wells (k)														
n	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
4	.167	.138	.118	.103	.091	.082	.074	.068	.062	.058	.054	.051	.048	.043	.038
5	.200	.167	.143	.125	.111	.100	.091	.083	.077	.071	.067	.062	.059	.053	.048
6	.231	.194	.167	.146	.130	.118	.107	.098	.091	.085	.079	.074	.070	.062	.057
7	.259	.219	.189	.167	.149	.135	.123	.113	.104	.097	.091	.085	.080	.072	.065
8	.286	.242	.211	.186	.167	.151	.138	.127	.118	.110	.103	.096	.091	.082	.074
9	.310	.265	.231	.205	.184	.167	.153	.141	.130	.122	.114	.107	.101	.091	.083
10	.333	.286	.250	.222	.200	.182	.167	.154	.143	.133	.125	.118	.111	.100	.091
11	.355	.306	.268	.239	.216	.196	.180	.167	.155	.145	.136	.128	.121	.109	.099
12	.375	.324	.286	.255	.231	.211	.194	.179	.167	.156	.146	.138	.130	.118	.107
13	.394	.342	.302	.271	.245	.224	.206	.191	.178	.167	.157	.148	.140	.126	.115
14	.412	.359	.318	.286	.259	.237	.219	.203	.189	.177	.167	.157	.149	.135	.123
15	.429	.375	.333	.300	.273	.250	.231	.214	.200	.187	.176	.167	.158	.143	.130
16	.444	.390	.348	.314	.286	.262	.242	.225	.211	.198	.186	.176	.167	.151	.138
17	.459	.405	.362	.327	.298	.274	.254	.236	.221	.207	.195	.185	.175	.159	.145
18	.474	.419	.375	.340	.310	.286	.265	.247	.231	.217	.205	.194	.184	.167	.153
19	.487	.432	.388	.352	.322	.297	.275	.257	.241	.226	.213	.202	.192	.174	.160
20	.500	.444	.400	.364	.333	.308	.286	.267	.250	.235	.222	.211	.200	.182	.167
25	.556	.500	.455	.417	.385	.357	.333	.312	.294	.278	.263	.250	.238	.217	.200
30	.600	.545	.500	.462	.429	.400	.375	.353	.333	.316	.300	.286	.273	.250	.231
35	.636	.583	.538	.500	.467	.437	.412	.389	.368	.350	.333	.318	.304	.280	.259
40	.667	.615	.571	.533	.500	.471	.444	.421	.400	.381	.364	.348	.333	.308	.286
45	.692	.643	.600	.562	.529	.500	.474	.450	.429	.409	.391	.375	.360	.333	.310
50	.714	.667	.625	.588	.556	.526	.500	.476	.455	.435	.417	.400	.385	.357	.333
60	.750	.706	.667	.632	.600	.571	.545	.522	.500	.480	.462	.444	.429	.400	.375
70	.778	.737	.700	.667	.636	.609	.583	.560	.538	.519	.500	.483	.467	.437	.412
80	.800	.762	.727	.696	.667	.640	.615	.593	.571	.552	.533	.516	.500	.471	.444
90	.818	.783	.750	.720	.692	.667	.643	.621	.600	.581	.562	.545	.529	.500	.474
100	.833	.800	.769	.741	.714	.690	.667	.645	.625	.606	.588	.571	.556	.526	.500

$2^{20} = 1{,}048{,}576$ terms. With two resamples we have $3^{20} = 3{,}486{,}784{,}401$ terms. In light of this, the required probabilities are computationally restricted to cases in which the required number of resamplings and number of monitoring wells are reasonably small. Fortunately, an excellent approximation using the Bonferonni inequality (Miller, 1985) can be derived easily. In this context, the Bonferonni inequality implies that if we construct a limit assuming $k = 1$, but actually apply it to $k = t$ monitoring wells, where $t > 1$, then the simultaneous probability that all t measurements will be included in the limit is approximately γ^t. In light of this, we can easily evaluate equation (2) for $k = 1$, but report $\gamma = \gamma^t$. The approximated probability is therefore:

$$\gamma \cong \left[\frac{n}{m+n} \sum_{j=1}^{m} \frac{\binom{m}{j}}{\binom{m+n-1}{j+n-1}} \right]^k \qquad (3)$$

Returning to our example of n = 16, k = 5, and m = 2, we find:

$$\gamma \cong \left[\frac{16}{2+16} \left(\frac{\binom{2}{1}}{\binom{2+16-1}{1+16-1}} + \frac{\binom{2}{2}}{\binom{2+16-1}{2+16-1}} \right) \right]^5$$

$$\gamma \cong \left[.8889 \left(\frac{2}{17} + 1 \right) \right]^5 = .968$$

Table 3. Probability That At Least One Out of Three Samples Will Be Below the Maximum of n Background Measurements At Each of k Monitoring Wells

Previous	Number of Monitoring Wells (k)														
n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	.971	.944	.917	.891	.866	.840	.816	.793	.770	.748	.727	.706	.686	.666	.647
5	.982	.962	.947	.930	.914	.898	.882	.866	.850	.835	.820	.806	.791	.777	.763
6	.988	.976	.965	.953	.942	.931	.920	.909	.898	.887	.877	.866	.856	.846	.836
7	.992	.983	.975	.967	.959	.951	.943	.935	.927	.920	.912	.904	.897	.889	.882
8	.994	.988	.982	.976	.970	.964	.958	.953	.947	.941	.936	.930	.924	.918	.913
9	.995	.991	.986	.982	.977	.973	.968	.964	.960	.955	.951	.947	.942	.938	.934
10	.997	.993	.990	.986	.983	.979	.976	.972	.969	.966	.962	.959	.955	.952	.949
11	.997	.995	.992	.989	.986	.984	.981	.978	.976	.973	.970	.968	.965	.962	.960
12	.998	.996	.993	.991	.989	.987	.985	.983	.980	.978	.976	.974	.972	.970	.968
13	.998	.996	.995	.993	.991	.989	.988	.986	.984	.982	.981	.979	.977	.976	.974
14	.999	.997	.996	.994	.993	.991	.990	.988	.987	.985	.984	.982	.981	.980	.978
15	.999	.998	.996	.995	.994	.993	.991	.990	.989	.988	.987	.985	.984	.983	.982
16	.999	.998	.997	.996	.995	.994	.993	.992	.991	.990	.989	.988	.987	.986	.985
17	.999	.998	.997	.996	.996	.995	.994	.993	.992	.991	.990	.990	.989	.988	.987
18	.999	.999	.998	.997	.996	.995	.995	.994	.993	.993	.992	.991	.990	.990	.988
19	.999	.999	.998	.997	.997	.996	.995	.995	.994	.994	.993	.992	.992	.991	.990
20	.999	.999	.998	.998	.997	.997	.996	.995	.995	.994	.994	.993	.993	.992	.992
25	1.00	.999	.999	.999	.998	.998	.998	.998	.997	.997	.997	.996	.996	.996	.995
30	1.00	1.00	.999	.999	.999	.999	.999	.999	.998	.998	.998	.998	.998	.997	.997
35	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.998	.998	.998
40	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999
45	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999
60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Previous	Number of Monitoring Wells (k)														
n	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
4	.560	.484	.419	.362	.314	.271	.235	.203	.175	.152	.131	.114	.098	.074	.056
5	.697	.637	.582	.532	.486	.444	.406	.371	.339	.310	.283	.259	.237	.198	.165
6	.787	.741	.698	.658	.619	.583	.549	.518	.487	.459	.432	.407	.384	.340	.302
7	.846	.811	.778	.745	.716	.686	.658	.631	.605	.580	.557	.534	.512	.471	.433
8	.886	.859	.833	.808	.784	.761	.738	.716	.694	.674	.653	.634	.616	.579	.544
9	.913	.892	.872	.853	.833	.815	.796	.778	.761	.744	.727	.711	.695	.664	.634
10	.932	.916	.900	.885	.869	.854	.839	.825	.810	.796	.783	.769	.756	.730	.705
11	.946	.934	.921	.908	.896	.884	.871	.860	.848	.836	.825	.814	.802	.781	.759
12	.957	.946	.936	.926	.916	.906	.896	.886	.876	.867	.857	.848	.839	.820	.802
13	.965	.956	.948	.939	.931	.923	.915	.906	.898	.890	.882	.875	.867	.851	.836
14	.971	.964	.957	.950	.943	.936	.929	.922	.916	.909	.902	.895	.889	.876	.863
15	.976	.970	.964	.958	.952	.946	.941	.935	.929	.923	.918	.912	.907	.896	.885
16	.980	.975	.969	.965	.960	.955	.950	.945	.940	.935	.930	.925	.921	.911	.902
17	.983	.978	.974	.970	.966	.961	.957	.953	.949	.945	.940	.936	.932	.924	.916
18	.985	.981	.978	.974	.970	.967	.963	.959	.956	.952	.949	.945	.942	.935	.928
19	.987	.984	.981	.978	.974	.971	.968	.965	.962	.959	.956	.952	.949	.943	.937
20	.989	.986	.983	.980	.978	.975	.972	.969	.967	.964	.961	.959	.956	.950	.945
25	.994	.992	.991	.989	.988	.986	.985	.983	.982	.980	.979	.977	.976	.973	.970
30	.996	.995	.995	.994	.993	.992	.991	.990	.989	.988	.987	.986	.985	.984	.982
35	.998	.997	.996	.996	.995	.995	.994	.994	.993	.993	.992	.991	.991	.989	.988
40	.998	.998	.998	.997	.997	.996	.996	.996	.995	.995	.994	.994	.994	.993	.992
45	.999	.999	.998	.998	.998	.997	.997	.997	.997	.996	.996	.996	.995	.995	.994
50	.999	.999	.999	.999	.998	.998	.998	.998	.997	.997	.997	.997	.997	.996	.996
60	1.00	.999	.999	.999	.999	.999	.999	.999	.998	.998	.998	.998	.998	.998	.997
70	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.998
80	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999	.999	.999	.999
90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999	.999	.999	.999	.999
100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.999	.999

various combinations of numbers of background samples and numbers of monitoring wells on the integrity of detection monitoring decisions. In practice, it is hard to imagine having more than a single resample (i.e., m = 2, see Table 2).

Use of these Tables is now illustrated with a series of examples.

3. Examples

Case 1

A facility obtained seven background measurements prior to operation and wants to identify the optimum detection monitoring plan for its 15 monitoring wells at a 95% confidence level. Since n is fixed at 7 and k is fixed at 15, we must identify an optimum number of resamplings such that $\gamma \geqslant .95$. Inspection of Table 2 for k = 15 and

Table 4. Comparison of Exact and Approximate Solutions

	1 Resample				2 Resamples		3 Resamples	
	K=5		K=10		K=5		K=6	
N	exact	approx	exact	approx	exact	approx	exact	approx
5	.923	.784	.726	.614	.928	.914	.987	.961
10	.933	.927	.882	.872	.984	.980	.995	.995
20	.979	.979	.961	.958	.997	.997	1.00	1.00
50	.995	.996	.993	.992	1.00	1.00	1.00	1.00
100	.999	.999	.998	.998	1.00	1.00	1.00	1.00

small numbers of background observations, that is to be applied to a large number of monitoring wells. As illustrated in the following example, a far more judicious choice is to use the method presented here to determine the number of background measurements that are required to insure 95% confidence that the maximum background measurement exceeds at least one of two new monitoring measurements (i.e., a single resample) at each of k monitoring wells. In practice, a single resample is commonly used as a method of verifying an anomalous result. If resampling a well that fails a traditional statistical test is permitted, we are in effect requiring that the limit exceed only one of two potential measurements.

Case 2

A facility with 20 monitoring wells is only permitted a single resampling by state law. How many background measurements must be obtained such that the maximum will have 95% probability of exceeding at least one of the two measurements at each of the 20 monitoring wells? The answer to this question can be found by inspecting Table 2 under the column $k = 20$. A background sample size of $n = 25$ yields $\gamma = .945$, and $n = 30$ yields $\gamma = .960$. Linear interpolation yields $n = 27$ ($\gamma = .951$). Alternatively, inspection of Table 5 reveals that for $k = 20$, $n = 30$ is the smallest number of background measurements that achieves 95% confidence with a single resampling.

Case 3

A new landfill has one year to obtain four quarterly measurements in a single well before operation. State law requires a single resampling. How many monitoring wells should the owner/operator install in order to obtain 95% confidence that at least one of the two measurements at each monitoring well will not exceed the largest of the four background measurements? Inspection of Table 2 reveals that it is hopeless; even with a single monitoring well, we can at most have .933 confidence. Inspection of Table 5 reveals that even with as few as three monitoring wells, three resamplings would be required to acheive a 95% confidence level. Furthermore, from a hydrogeological perspective, characterizing background water quality with a single background well is not a very reasonable choice. From a statistical perspective, a single background well produces a confound between contamination and spatial variability that cannot be resolved without additional background wells. Finally, the selection of monitoring wells should be based on a detailed hydrogeological understanding of the site and not simply statistical optimization. Conversely, placing large numbers of monitoring wells on a site may be of some hydrogeological interest, but it will make it almost impossible to develop a statistically rigorous detection monitoring program.

Case 4

Consider a facility with five upgradient wells monitored quarterly for one year ($n = 20$), and 12 downgradient monitoring wells ($k = 12$). In the event of a statistical failure, the owner/operator is permitted to resample the well in question, and if the resample does not exceed the statistical limit, he may continue with normal detection monitoring in the following quarter. Benzene is of particular interest at this facility due to high levels of benzene in the leachate. Of the 20 background measurements, there were 17 nondetects and three detected values of 10, 12, and 16 ppb, respectively. The upper prediction limit for benzene is, therefore, 16 ppb. Inspection of Table 2 reveals that with $n = 20$, $k = 12$, and $m = 2$, we can have 94.9% confidence that either the initial measurement or the resample will not exceed 16 ppb in each of the 12 downgradient monitoring wells. For example, if 11 of the 12 downgradient wells yielded nondetects for benzene and one well yielded a value of 20 ppb, then we would only resample that single well. If the resample exceeded 16 ppb, a statistical failure would be recorded; otherwise, the owner/operator would continue with normal detection monitoring on the next quarterly sampling event. It is important to realize that we do not have to resample the 11 wells that did not exceed the limit on the first sample. The prediction limit is for *at least* one of two samples; therefore, the requirement is met if the first sample does not exceed the limit.

4. Discussion

Nonparametric prediction limits provide a straightforward approach to detection monitoring for a wide variety of potential indicator parameters at waste disposal facilities. With the use of resampling as a fundamental part of the probability statement, remarkably small background sample sizes are required to provide simultaneous 95% upper predictor limits for relatively large numbers of monitoring wells. Without taking resampling into consideration, however, nonparametric prediction limits require background sample sizes that are generally too large to be of practical value. This point also has been raised in the new statistical rule (USEPA, 1988).

An important feature of the resampling is that the repeated samples must be independent. This rules out possible strategies in which a single sample is split into aliquots and simply reanalyzed. Similarly, in areas in which ground water moves slowly, it may be difficult to get repeat samples in a reasonable time-frame to both insure independence and protect the environment. The potential effect of correlated measurements on this method is clear. Since we only resample elevated initial measurements, if the resample and the initial sample are correlated, we would expect the resample to have an increased probability of also being elevated and have an increased likelihood of exceeding the limit. The result, of course, is an increased false positive rate and a decision rule that is more protective of the environment than of industry. In practice, however, resamples are generally not taken within days of the initial sample. With the amount of time required for transport, analytical work, and sampling, the resample is typically obtained within a few weeks or even a month of the initial sample, and as such, serial dependence may be less of a problem.

In the examples considered here, we have only dealt

KT RECEIVED ON
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Dept. of Environmental Quality
Waste & Underground
Tank Management Bureau

BUTTE-SILVER BOW
PUBLIC WORKS DEPARTMENT
UTILITIES DIVISION
126 West Granite Street Butte, MT 59701
(406) 497-6518

March 27, 2013

Mr. Martin Van Oort
Permitting and Compliance Division
Solid Waste Program
P.O. Box 200901
Helena, Montana 59620-0901

RE: Closed Butte-Silver Bow County Landfill – License #20
Request for Change in Sampling and Analytical Constituents

Dear Martin,

Attached is a request prepared for Butte-Silver Bow County by our contractor, Pioneer Technical Service to discontinue sampling and analyzing for some constituents listed in Appendix I and II to 40 CFR Part 258 as directed in ARM 17.50.1307 for the Closed Butte-Silver Bow County Landfill-License #20. As presented in the attached request several analytes have not been detected in any sampling event or have been below background values. If you have questions after reviewing this request please contact me at 406-497-6518 or our representatives at Pioneer, Brad Hollamon or Julie Flammang at 406-490-7678 or 406-498-0628 respectively. We would appreciate your consideration in this matter.

Sincerely,

Rick Larson
Butte- Silver Bow County Public Works Department

cc: J.D. Emmert Pioneer
M. Mihailovich, Pioneer

PIONEER
TECHNICAL SERVICES, INC.

March 27, 2013

Mr. Martin Van Oort
Permitting and Compliance Division
Solid Waste Program
P.O. Box 200901
Helena, MT 59620-0901

RE: Closed Butte-Silver Bow County Landfill – License #20
Request for Change in Sampling and Analytical Constituents

Dear Martin:

After a review of the analytical results from the last 12 years of sampling at the closed Butte-Silver Bow County Landfill – License #20, Butte-Silver Bow County would like to propose discontinuing the sampling and analyzing of some constituents listed in Appendix I and II to 40 CFR Part 258 as directed in ARM 17.50.1307.

We would like to discontinue sampling and analyzing for several metals in the monitoring wells (attached Figure) MBMG-2, CLK-1 and CLK-2; antimony, barium, mercury, selenium, silver, thallium and vanadium. Table 1 and Figures 1 – 7 present data for each respective metal compared to MBMG-2, which is the designated background monitoring well. No well has ever reported values near the Montana Human Health Standard (MHHS) and CLK-1 and CLK-2 have been below the background concentrations present at MBMG-2. Vanadium is not listed in either Appendix I or II to 40 CFR Part 258.

Only two compounds in the semi-volatile analytical method, EPA Method SW8270, have ever been detected; 2,4-dimethylphenol in monitoring well, BSB-A6R, (attached figure) during the September 2001 sampling event and bis(2-ethylhexyl)phthalate in seven sampling events since June of 2001. A summary table of detections for bis(2-ethylhexyl)phthalate is presented below. Note that all results are J flagged, meaning an estimated quantity; the analyte is present but at concentrations less than the practical quantitation limit of 10 μg/L. Phthalate compound detections can often be a result of laboratory contamination. The lone detection of 2,4-dimethylphenol reported a concentration of 1.8 μg/L with a J flag.

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Table 2
Reported Concentrations of bis(2-ethylhexyl)phthalate Since June, 2001

Well Number	Sampling Event	Concentration
BSB-A6R	September 2010	5.33J
BSB-A6R	September 2002	3.3J
BSB-A6R	March 2002	1.8J
BSB-A6R	September 2001	2.8J
BSB-A6R	June 2001	9.2J
BSB-A1	April 2010	8.73J
BSB-A5	September 2003	2.0J

J indicates an estimated quantity, the analyte is present but at concentrations less than the practical quantitation limit.

BSB would like to discontinue sampling and analyzing for EPA Method 8270A, Semi-Volatile Analysis in MBMG-2, BSB-A1, BSB-A5, and BSB-A6R.

Organochlorine herbicides, pesticides and Polychlorinated biphenyls analyses have resulted in the detections listed in Table 3:

Table 3
Reported Concentrations of Chlorinated Herbicides and Pesticides since June, 2001

Well Number	Sampling Event	Analyte	Concentration (µg/L)	Note
BSB-A6R	October 2012	Dicamba	0.093J	Health Advisory is 200 µg/L
BSB-A6R	October 2012	2,3,5-TP (Silvex)	0.11J	MCL is 50 µg/L
MBMG-2	March 2012	2,4-D	0.30J	MCL is 70 µg/L
BSB-A5	March 2012	2,4-D	0.23J	MCL is 70 µg/L
BSB-A6R	March 2012	2,3,5-TP (Silvex)	0.11J	MCL is 50 µg/L
BSB-A6R	September 2010	Dicamba	0.073J	Health Advisory is 200 µg/L
BSB-A6R	September 2010	2,3,5-TP (Silvex)	0.14J	MCL is 50 µg/L
BSB-A6R	October 2009	2,4-D	1.1	MCL is 70 µg/L
BSB-A1	September 2004	Pentachlorophenol	0.13	MCL is 1 µg/L
BSB-A5	September 2004	Picloram	1.6	MCL is 500 µg/L
BSB-A5	September 2001	Picloram	0.60	MCL is 500 µg/L
BSB-A6R	September 2001	Picloram	0.28J	MCL is 500 µg/L
MBMG-2	September 2001	Picloram	0.94	MCL is 500 µg/L

J indicates an estimated quantity, the analyte is present but at concentrations less than the practical quantitation limit.

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Five different compounds, all organochlorine herbicides, have been detected and all have been well below the MCLs. We would like to discontinue sampling and analysis in MBMG-2, BSB-A1, BSB-A5, and BSB-A6R for EPA Analytical Methods 8081 (organochlorine pesticides) and 8082 (polychlorinated biphenyls) because none have been detected. Picloram and pentachlorophenol, EPA Analytical Method 8151, (organochlorine herbicides) have not been detected since 2004. Dicamba and Silvex, though reported have been J flagged, meaning that is an estimated quantity, the analyte is present but at concentrations less than the method detection limit. 2,4-D has had one result above the RRV of 1 µg/L in monitoring well, BSB-A6R, located near the center of the landfill (see attached Figure). It was not detected the following year and in 2012 was detected again in BSB-A6R at levels below the designated background monitoring well (MBMG-2). The 2012 results were below the RRV and J flagged as well. We would also like you to consider allowing BSB to discontinue sampling for EPA Method 8151 (organochlorine herbicides) in MBMG-2, BSB-A1, BSB-A5, and BSB-A6R.

In addition, Pace Analytical Laboratories has informed us that we will need to use EPA Analytical Method 8011 instead of EPA Analytical Method 8260 to meet the Required Reporting Values in the 2012 release of Circular DEQ-7, Montana Numeric Water Quality Standards for 1,2-Dibromo-3-chloropropane and 1,2-Dibromoethane. Please let me know if this is an acceptable substitution.

I appreciate your review of this matter and if you have any questions about this request please give Brad Hollamon or me a call at 406-490-7678 or 406-498-0628.

Sincerely,

Julie Flammang

Julie Flammang
Environmental Scientist

cc: Rick Larson, BSB Public Works
J.D. Emmert Pioneer
M. Mihailovich, Pioneer

BUTTE-SILVER BOW CLASS II LANDFILL

UPGRADIENT/BACKGROUND WELLS:

WELL	GROUP	DATE (M/YY)	Sb mg/L	Sb FLAG	Ba mg/L	Ba FLAG	Hg mg/L	Hg FLAG	Se mg/L	Se FLAG	Ag mg/L	Ag FLAG	Tl mg/L	Tl FLAG	V mg/L	V FLAG
MBMG-2	BKGD	Feb-94	0.00105		0.133		0.0000485		0.001		0.000105		0.00057		0.012	
MBMG-2	BKGD	Aug-94	0		0		0		0		0		0		0	
MBMG-2	BKGD	Jan-95	0.004		0.142		0.0000485		0.00041		0.000105		0.006		0.01	
MBMG-2	BKGD	Feb-95	0.009		0.136		0.0000485		0.00041		0.000105		0.006		0.006	
MBMG-2	BKGD	Mar-95	0.004		0.132		0.0002		0.00041		0.000105		0.005		0.013	
MBMG-2	BKGD	Aug-95	0.00105		0.117		0.0000485		0.00041		0.000105		0.007		0.008	
MBMG-2	BKGD	Feb-96	0.00105		0.138		0.0001		0.00041		0.000105		0.00057		0.012	
MBMG-2	BKGD	Mar-97	0.00105		0.141		0.0000485		0.003		0.000105		0.003		0.01	
MBMG-2	BKGD	Sep-97	0.00105		0.15		0.0000485		0.00041		0.000105		0.00057		0.009	
MBMG-2	BKGD	Apr-98	0.00105		0.132		0.0000485		0.001		0.000105		0.00057		0.007	
MBMG-2	BKGD	Oct-98	0.00105		0.145		0.0000485		0.00041		0.000105		0.00057		0.009	
MBMG-2	BKGD	Jun-99	0.00105		0.158		0.0000485		0.00041		0.000105		0.00057		0.006	
MBMG-2	BKGD	Dec-99	0.00105		0.155		0.0000485		0.00041		0.000105		0.00057		0.007	
MBMG-2	BKGD	Jun-00	0.00105		0.15		0.0000485		0.00041		0.001		0.00057		0.007	
MBMG-2	BKGD	Dec-00	0.003		0.13		0.0000485		0.00041		0.000105		0.00057		0.004	
MBMG-2	BKGD	Jun-01	0.00105		0.118		0.000092		0.0015		0.000105		0.0013		0.0077	
MBMG-2	BKGD	Oct-01	0.002		0.13		0.0000485		0.00041		0.000105		0.00057		0.009	
MBMG-2	BKGD	Mar-02	0.00105		0.173		0.0000485		0.0018		0.000105		0.00057		0.0115	
MBMG-2	BKGD	Sep-02	0.0034		0.143		0.00005		0.00041		0.000105		0.00057		0.0026	
MBMG-2	BKGD	Apr-03	0.0009		0.139		0.00005		0.00041		0.000105		0.00002		0.0105	
MBMG-2	BKGD	Sep-03	0.0011		0.179		0.00005		0.001		0.000105		0.00005		0.0026	
MBMG-2	BKGD	Mar-04	0.00025		0.124		0.00005		0.00041		0.000105		0.00005		0.0076	
MBMG-2	BKGD	Sep-04	0.00025		0.132		0.00005		0.0031		0.000105		0.00005		0.0065	
MBMG-2	BKGD	Mar-05	0.00025		0.123		0.00005		0.003		0.000105		0.00005		0.0081	
MBMG-2	BKGD	Sep-05	0.00025		0.138		0.00005		0.003		0.000105		0.00005		0.0077	
MBMG-2	BKGD	Mar-06	0.00051		0.137		0.00005		0.0011		0.000105		0.00005		0.00861	
MBMG-2	BKGD	Sep-06	0.00025		0.138		0.00005		0.0022		0.000105		0.00006		0.0102	
MBMG-2	BKGD	Mar-07	0.00025		0.126		0.00005		0.0024		0.000105		0.00005		0.0094	
MBMG-2	BKGD	Sep-07	0.00025		0.136		0.00005		0.00237		0.000105		0.00005		0.00732	
MBMG-2	BKGD	Mar-08	0.00025		0.122		0.00005		0.00041		0.000105		0.00005		0.00611	
MBMG-2	BKGD	Sep-08	0.00025		0.01		0.00005		0.00041		0.000105		0.00005		0.0026	
MBMG-2	BKGD	Mar-09	0.005		0.1		0.00100		0.005		0.005		0.00500		0.1	
MBMG-2	BKGD	Oct-09	0.0005	U	0.14		0.00020	U	0.0007		0.0005	U	0.00050	U	0.0067	
MBMG-2	BKGD	Apr-10	0.0005	U	0.13		0.00020	U	0.0008		0.0005	U	0.00010	U	0.0062	
MBMG-2	BKGD	Sep-10	0.0005	U	0.14		0.00020	U	0.00054		0.0005	U	0.00010	U	0.0072	
MBMG-2	BKGD	Apr-11	0.0005	U	0.14		0.00020	U	0.00054		0.0005	U	0.00010	U	0.0069	
MBMG-2	BKGD	Sep-11	0.0005	U	0.15		0.00020	U	0.00066		0.0005	U	0.00010	U	0.0072	
MBMG-2	BKGD	Mar-12	0.0005	U	0.16		0.00020	U	0.00063		0.0005	U	0.00010	U	0.007	
MBMG-2	BKGD	Oct-12	0.0005	U	0.13		0.00020	U	0.00063		0.0005	U	0.00010	U	0.0062	
Maximum Conc.	MBMG-2		0.009		0.179		0.001		0.005		0.005		0.007		0.1	
Minimum Conc.	MBMG-2															
MAXIMUM BACKGROUND CONC.			**0.009**		**0.179**		**0.001**		**0.005**		**0.005**		**0.007**		**0.1**	
MINIMUM BACKGROUND CONC.																
CLK-1	BASELINE	Jul-96														
CLK-1	BASELINE	Aug-96														
CLK-1	BASELINE	Mar-97	0.00105		0.031		0.00005	U	0.003		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Sep-97	0.00105		0.032		0.00005	U	0.00041		0.005		0.002		0.012	
CLK-1	BASELINE	Apr-98	0.00105		0.029		0.00005	U	0.00041		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Oct-98	0.00105		0.035		0.00005	U	0.00041		0.000105		0.002		0.019	
CLK-1	BASELINE	Jun-99	0.00105		0.03		0.00005	U	0.00041		0.000105		0.00057		0.018	
CLK-1	BASELINE	Dec-99	0.003		0.037		0.00005	U	0.00041		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Jun-00	0.00105		0.032		0.00005	U	0.00041		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Dec-00	0.00105		0.046		0.00005	U	0.00041		0.000105		0.00057		0.008	
CLK-1	BASELINE	Jun-01	0.00105		0.03		0.00005	U	0.00076		0.000105		0.00011		0.0012	
CLK-1	BASELINE	Oct-01	0.00105		0.033		0.00005	U	0.00041		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Sep-02	0.311		0.032		0.00005	U	0.00041		0.000105		0.00057		0.0026	
CLK-1	BASELINE	Apr-03	0.0566		0.041		0.00005	U	0.00041		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Sep-03	0.00025		0.031		0.00005	U	0.00092		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Mar-04	0.00025		0.028		0.00005	U	0.00041		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Jun-04	0.00025		0.029		0.00005	U	0.0044		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Mar-05	0.00025		0.031		0.00005	U	0.0083		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Sep-05	0.00025		0.034		0.00005	U	0.0109		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Mar-06	0.00039		0.024		0.00005	U	0.0033		0.000105		0.00021		0.0026	
CLK-1	BASELINE	Sep-06	0.00025		0.028		0.00005	U	0.0101		0.000105		0.00008		0.0026	
CLK-1	BASELINE	Mar-07	0.00025		0.029		0.00005	U	0.0065		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Sep-07	0.00025		0.028		0.00005	U	0.0045		0.000105		0.00004		0.0026	
CLK-1	BASELINE	Mar-08	0.00025		0.031		0.00005	U	0.00041		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Sep-08	0.00025		0.024		0.00005	U	0.00041		0.000105		0.00005		0.0026	
CLK-1	BASELINE	Mar-09	0.0001		0.026		0.00020	U	0.0005		0.0005		0.00050		0.00035	
CLK-1	BASELINE	Oct-09	0.0005	U	0.024		0.00020	U	0.0005	U	0.0005	U	0.00050	U	0.00039	
CLK-1	BASELINE	Apr-10	0.005	U	0.023		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.0004	
CLK-1	BASELINE	Sep-10	0.005	U	0.024		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.00056	
CLK-1	BASELINE	Apr-11	0.0005	U	0.022		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.00038	

U - compound not detected

J - compound detected, but concentration less than quantitation limit

4/4/2013

BUTTE SILVER BOW CLASS II LANDFILL

WELL	GROUP	DATE (M/YY)	Sb mg/L	Sb FLAG	Ba mg/L	Ba FLAG	Hg mg/L	Hg FLAG	Se mg/L	Se FLAG	Ag mg/L	Ag FLAG	Tl mg/L	Tl FLAG	V mg/L	V FLAG
CLK-1	BASELINE	Sep-11	0.0005	U	0.022		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.00039	
CLK-1	BASELINE	Mar-12	0.0005	U	0.023		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.00038	
CLK-1	MONIT	Oct-12	0.00027	J	0.025		0.00020	U	0.00021	J	0.0005	U	0.00010	U	0.00033	

Min. Baseline Conc. CLK-1																
Max. Baseline Conc. CLK-1			0.311		0.046		0.0002		0.0109		0.005		0.002		0.019	
Latest Sample Exceed Max. Baseline?			**No**		**No**		**No**		**No**		**No**		**No**		**No**	
Latest Sample Exceed Max. Background?			**No**		**No**		**No**		**No**		**No**		**No**		**No**	

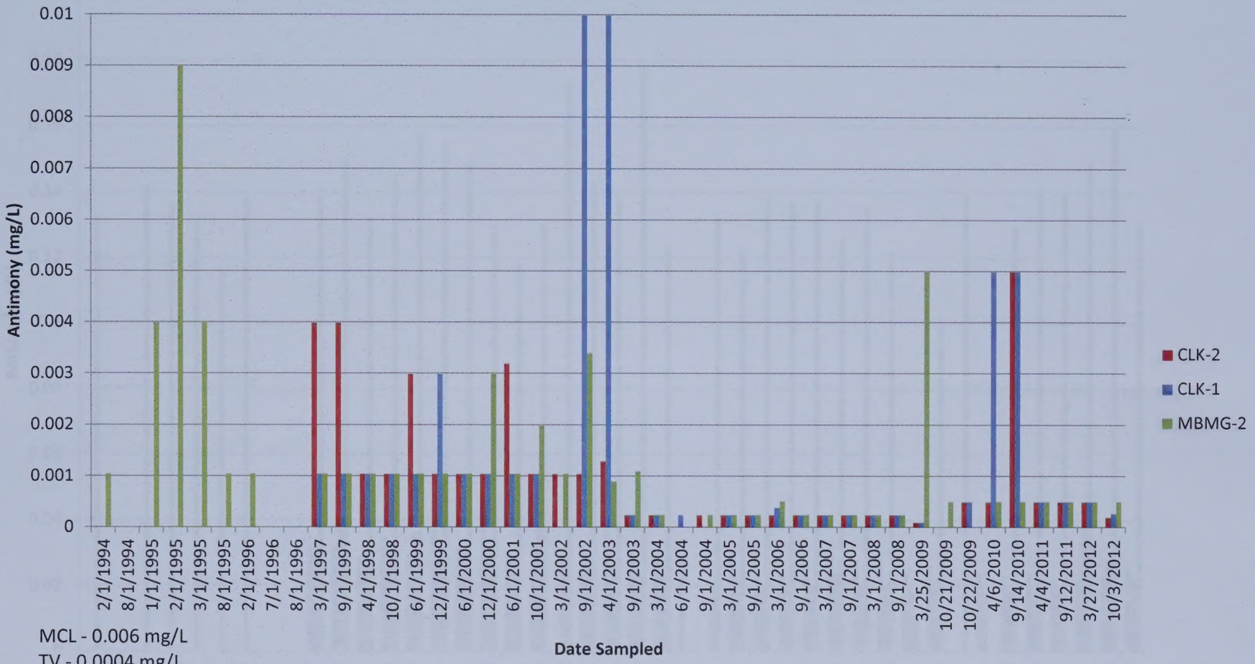
WELL	GROUP	DATE (M/YY)	Sb mg/L	Sb FLAG	Ba mg/L	Ba FLAG	Hg mg/L	Hg FLAG	Se mg/L	Se FLAG	Ag mg/L	Ag FLAG	Tl mg/L	Tl FLAG	V mg/L	V FLAG
CLK-2	BASELINE	Mar-97	0.004		0.032		0.0001		0.006		0.000105		0.003		0.0026	
CLK-2	BASELINE	Sep-97	0.004		0.04		0.0000485		0.00041		0.003		0.00057		0.004	
CLK-2	BASELINE	Apr-98	0.00105		0.032		0.0000485		0.001		0.000105		0.00057		0.004	
CLK-2	BASELINE	Oct-98	0.00105		0.031		0.0002		0.00041		0.000105		0.00057		0.0026	
CLK-2	BASELINE	Jun-99	0.003		0.036		0.0000485		0.00041		0.000105		0.00057		0.0026	
CLK-2	BASELINE	Dec-99	0.00105		0.03		0.0000485		0.00041		0.000105		0.00057		0.0026	
CLK-2	BASELINE	Jun-00	0.00105		0.03		0.0000485		0.00041		0.001		0.00057		0.0026	
CLK-2	BASELINE	Dec-00	0.00105		0.027		0.0000485		0.00041		0.000105		0.003		0.0026	
CLK-2	BASELINE	Jun-01	0.0032		0.029		0.00027		0.00041		0.000105		0.00011		0.0012	
CLK-2	BASELINE	Oct-01	0.00105		0.052		0.00010		0.00041		0.000105		0.00057		0.007	
CLK-2	BASELINE	Mar-02	0.00105		0.029		0.00018		0.0014		0.000105		0.00072		0.0026	
CLK-2	BASELINE	Sep-02	0.00105		0.03		0.00012		0.00041		0.000105		0.00057		0.0026	
CLK-2	BASELINE	Apr-03	0.0013		0.026		0.00012		0.00041		0.000105		0.00002		0.0025	
CLK-2	BASELINE	Sep-03	0.00025		0.025		0.00019		0.0026		0.000105		0.00005		0.0041	
CLK-2	BASELINE	Mar-04	0.00025		0.023		0.0000485		0.00041		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Sep-04	0.00025		0.021		0.0000485		0.0037		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Mar-05	0.00025		0.022		0.0000485		0.0049		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Sep-05	0.00025		0.02		0.00025		0.0047		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Mar-06	0.00025		0.02		0.0000485		0.0024		0.000105		0.00013		0.0026	
CLK-2	BASELINE	Sep-06	0.00025		0.02		0.0000485		0.0037		0.000105		0.00009		0.0026	
CLK-2	BASELINE	Mar-07	0.00025		0.024		0.0000485		0.0033		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Sep-07	0.00025		0.021		0.00005		0.00275		0.000105		0.00004		0.0026	
CLK-2	BASELINE	Mar-08	0.00025		0.02		0.00004		0.00041		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Sep-08	0.00025		0.02		0.00005		0.00041		0.000105		0.00005		0.0026	
CLK-2	BASELINE	Mar-09	0.0001		0.019		0.00020		0.0005		0.0005		0.00050		0.0023	
CLK-2	BASELINE	Oct-09	0.0005	U	0.018		0.00020	U	0.0005	U	0.0005	U	0.00050	U	0.0023	
CLK-2	BASELINE	Apr-10	0.0005	U	0.019		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.0023	
CLK-2	BASELINE	Sep-10	0.005	U	0.018		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.0025	
CLK-2	BASELINE	Apr-11	0.0005	U	0.02		0.00020	U	0.0005	U	0.0005	U	0.00010	U	0.0023	
CLK-2	BASELINE	Sep-11	0.0005	U	0.038		0.00020	U	0.00093		0.0005	U	0.00010	U	0.0036	
CLK-2	BASELINE	Mar-12	0.0005	U	0.028		0.00020	U	0.00088		0.0005	U	0.00010	U	0.0031	
CLK-2	MONIT	Oct-12	0.0002	J	0.022		0.00020	U	0.00055		0.0005	U	0.00010	U	0.0024	

Min. Baseline Conc. CLK-2																
Max. Baseline Conc. CLK-2			0.005		0.052		0.00027		0.006		0.003		0.003		0.007	
Latest Sample Exceed Max. Baseline?			**No**		**No**		**No**		**No**		**No**		**No**		**No**	
Latest Sample Exceed Max. Background?			**No**		**No**		**No**		**No**		**No**		**No**		**No**	

U - compound not detected

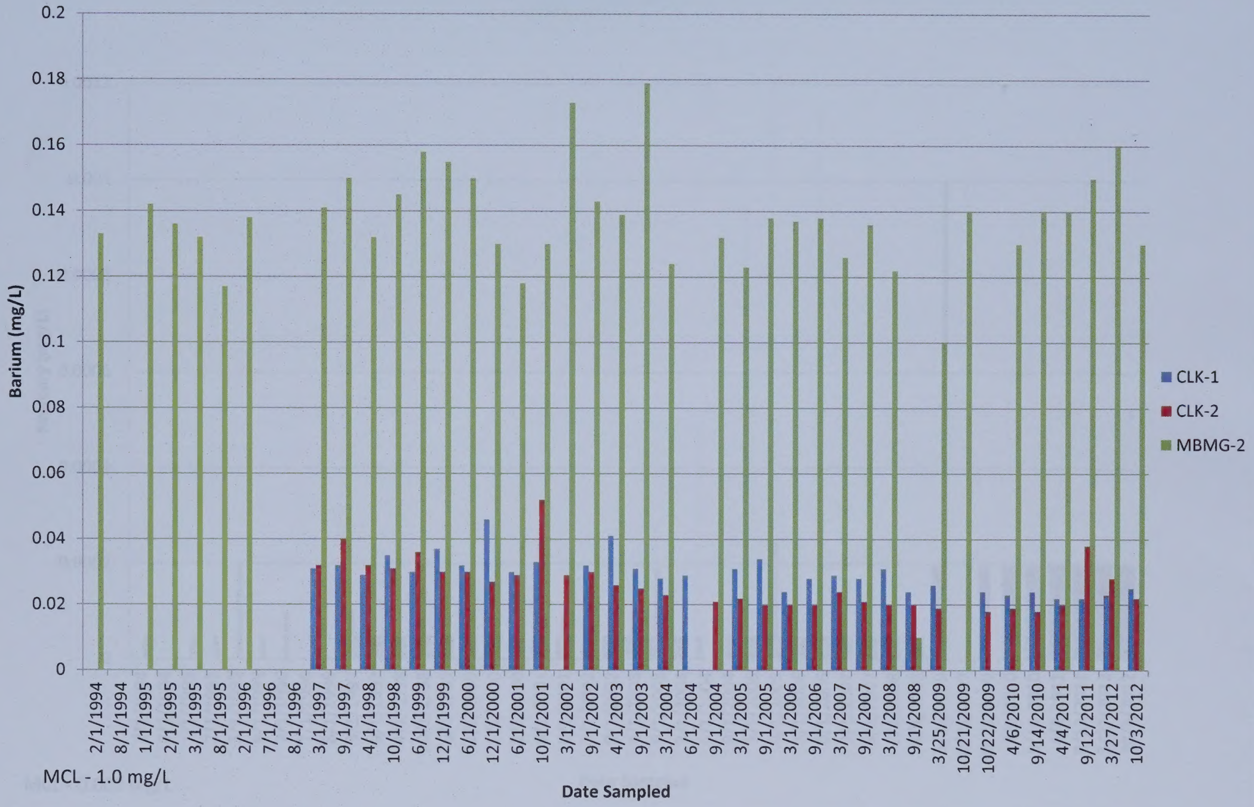
J - compound detected, but concentration less than quantitation limit

Figure 1
Antimony Concentrations by Well for each Sampling Event



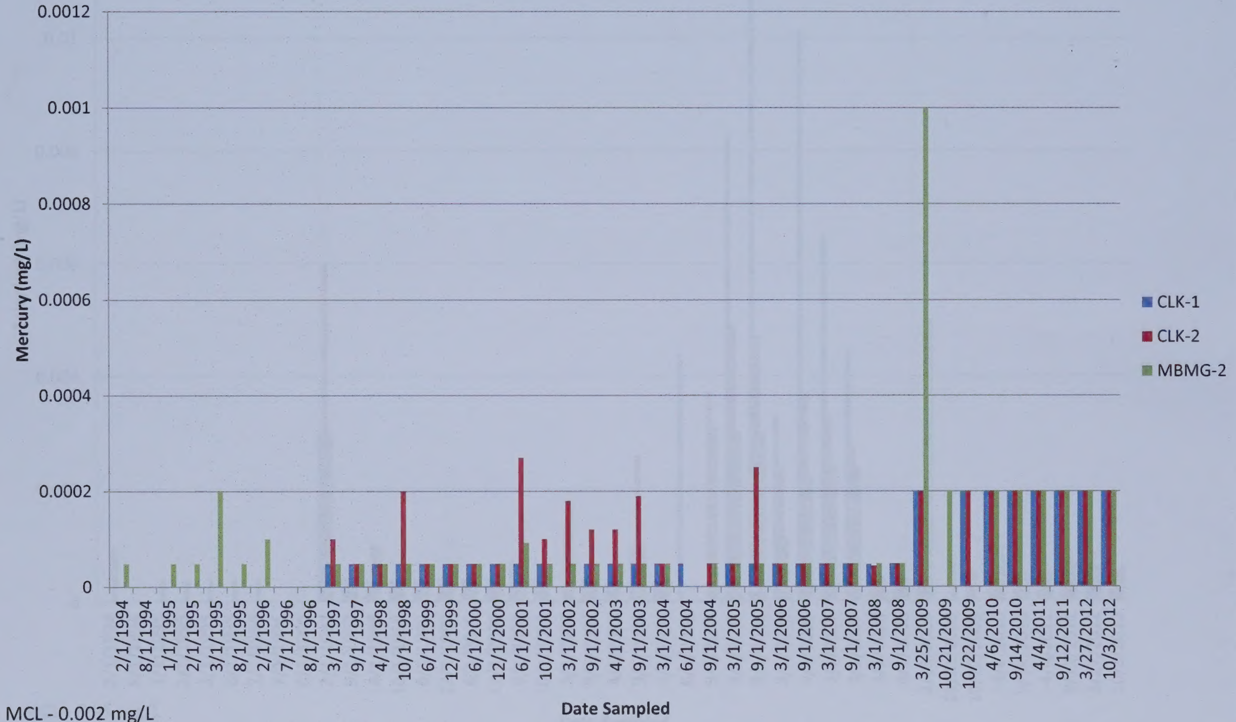
MCL - 0.006 mg/L
TV - 0.0004 mg/L

Figure 2
Barium Concentrations by Well for each Sampling Event



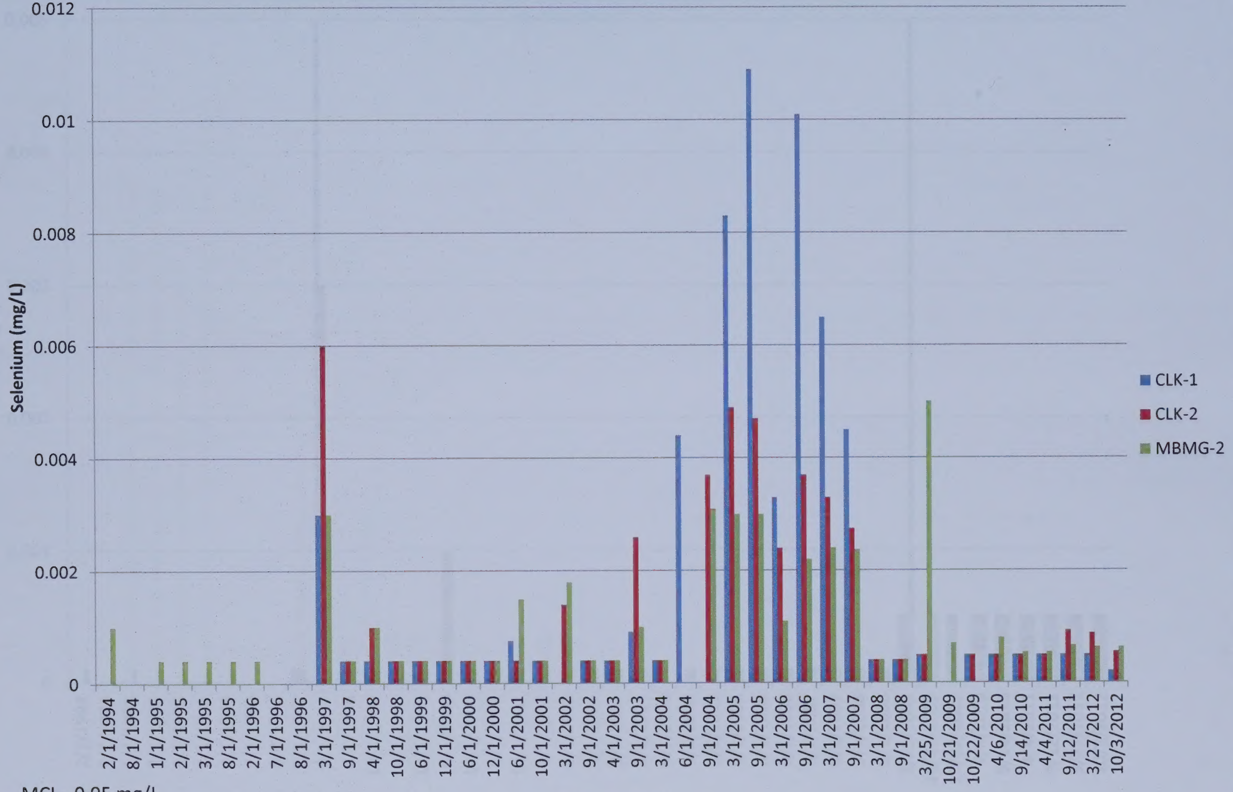
MCL - 1.0 mg/L

Figure 3
Mercury Concentrations By Well for each Sampling Event



MCL - 0.002 mg/L

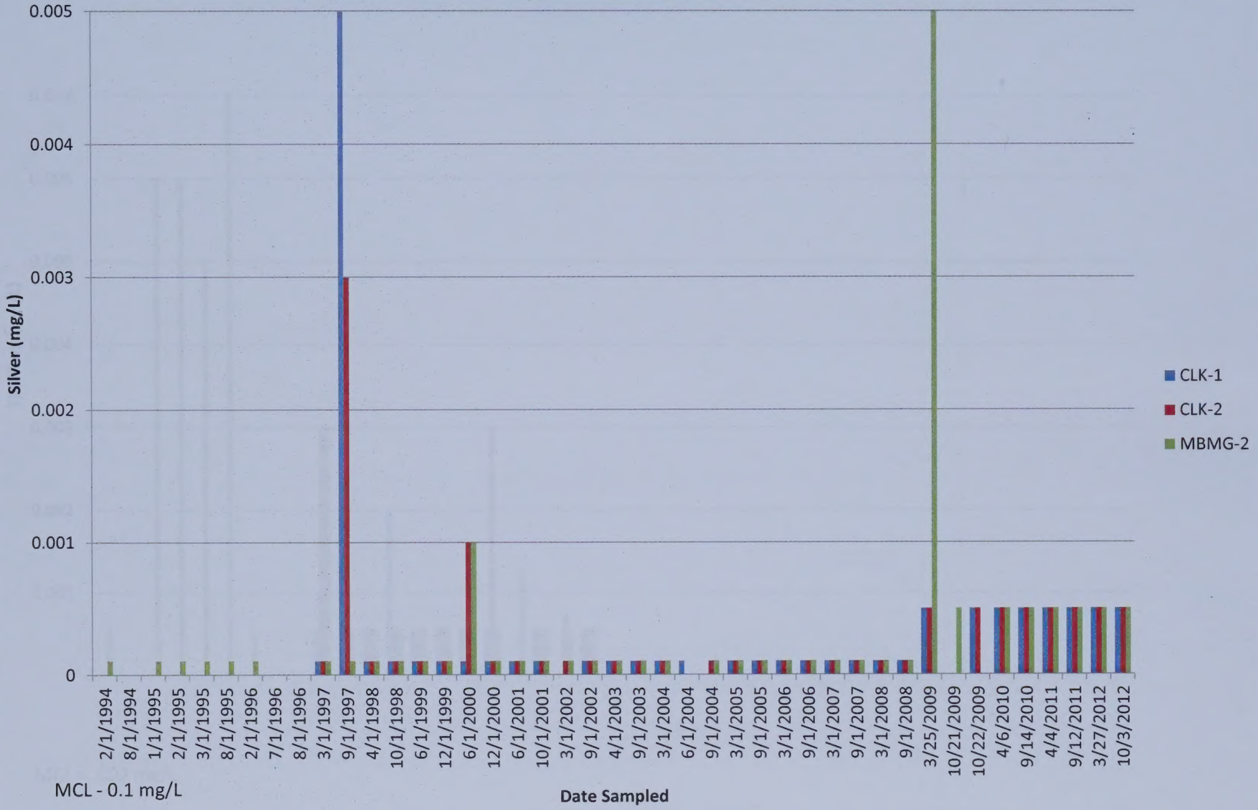
Figure 4
Selenium Concentrations by Well for each Sampling Event



MCL - 0.05 mg/L

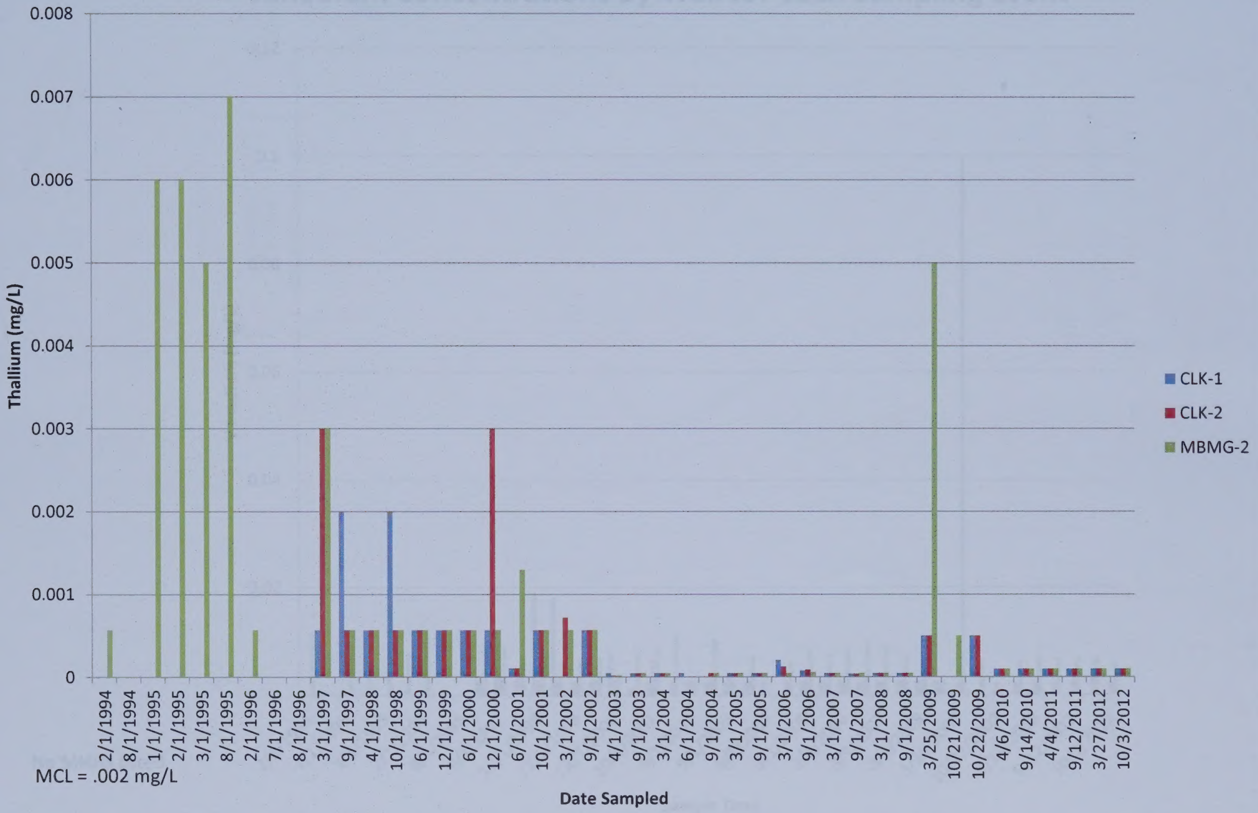
Date Sampled

Figure 5
Silver Concentrations by Well from each Sampling Event



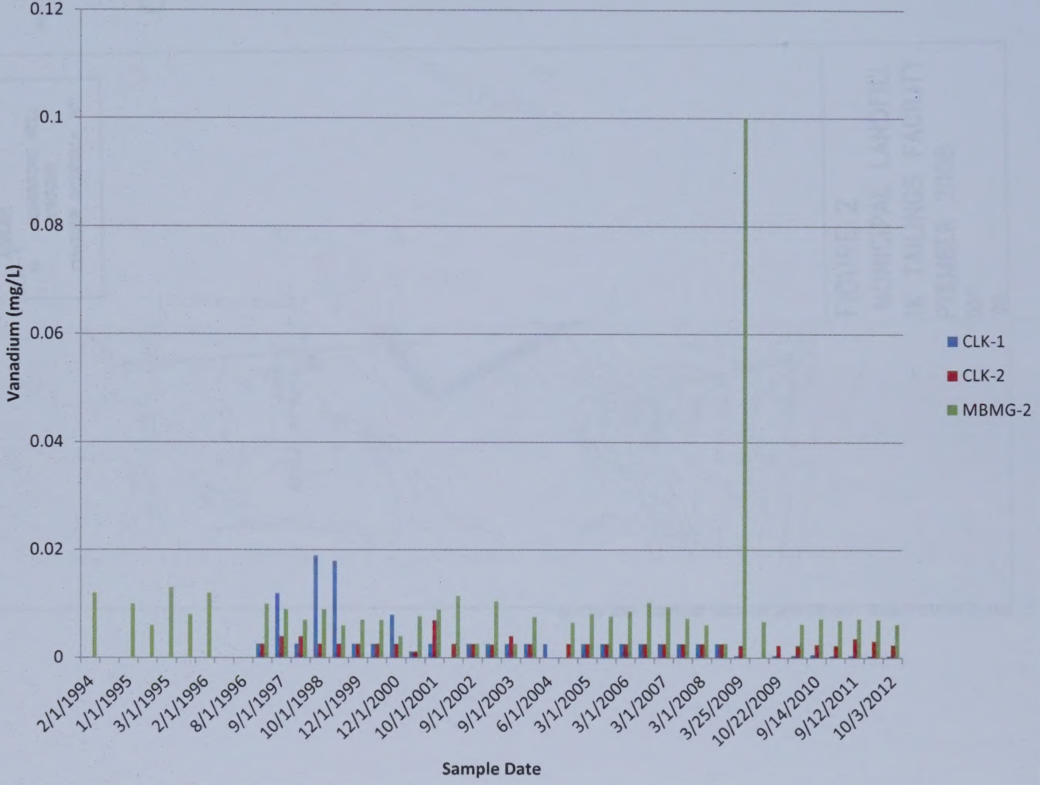
MCL - 0.1 mg/L

Figure 6
Thallium Concentrations by Well for each Sampling Event



MCL = .002 mg/L

Figure 7
Vanadium Concentrations by Well for each Sampling Event



No MHHS listed

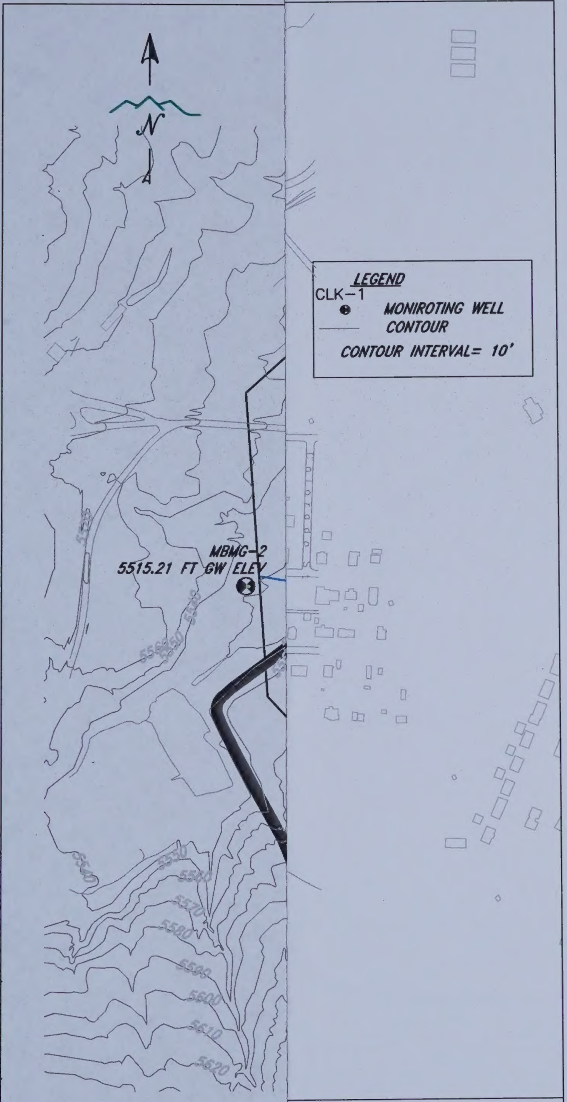
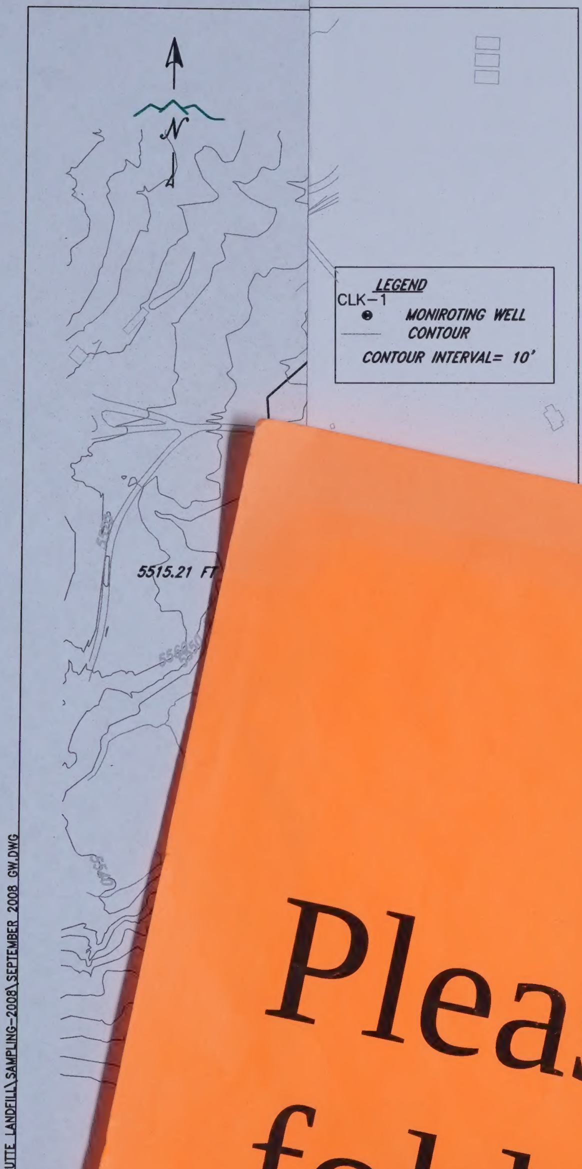

N
LEGEND
CLK-1
MONIROTING WELL
CONTOUR
CONTOUR INTERVAL= 10'
MBMG-2
5515.21 FT GW ELEV
5520
5530
5560
5550
5540
5550
5560
5570
5580
5590
5600
5610
5620

FIGURE 2
MUNICIPAL LANDFILL
RK TAILINGS FACILITY
PTEMBER 2008
00"
/08

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2008\SEPTEMBER 2008 GW.DWG

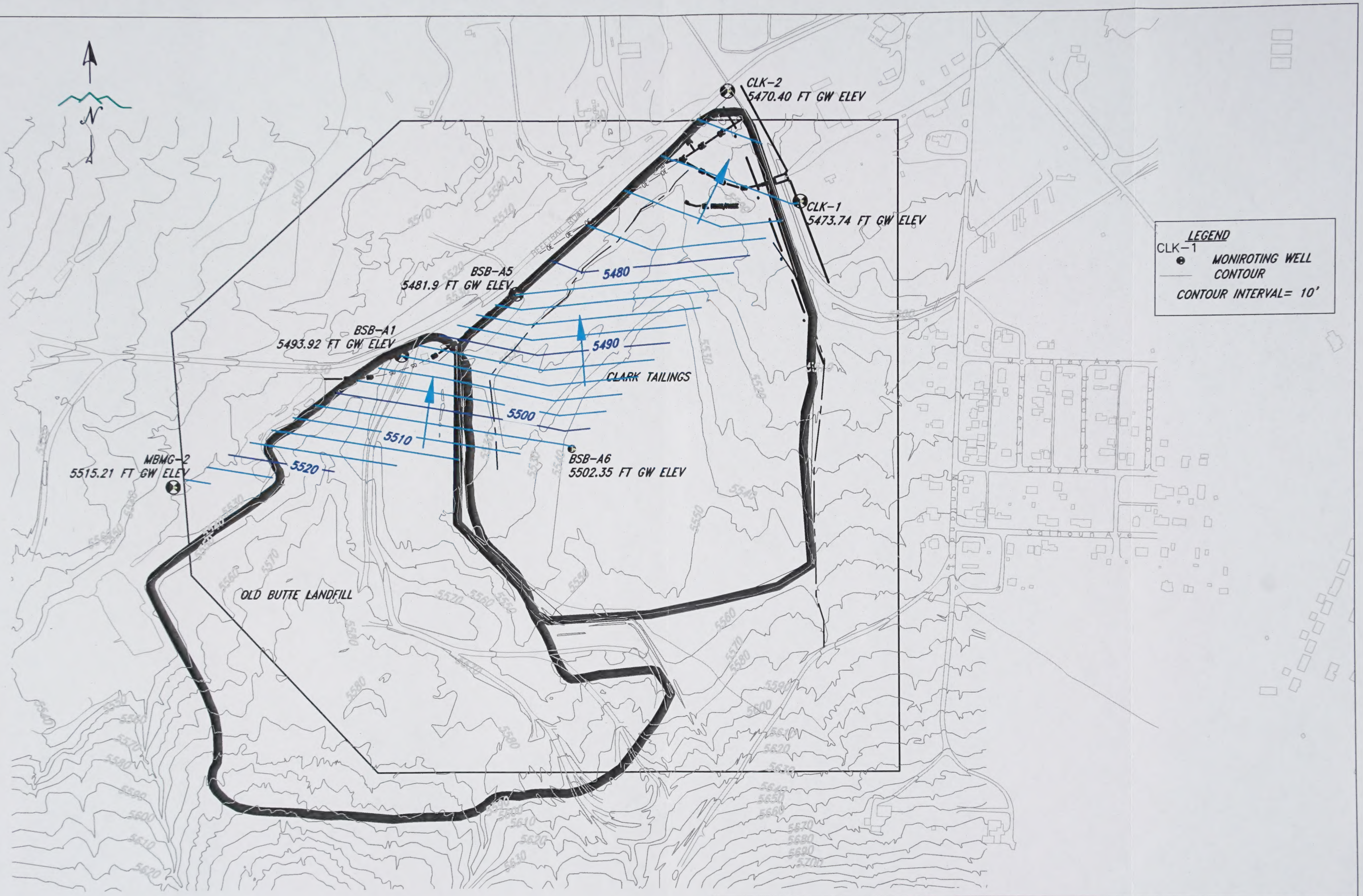
RECEIVED
APR 08 2013
DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU


N
LEGEND
CLK-1
MONIROTING WELL
CONTOUR
CONTOUR INTERVAL= 10'
5515.21 FT
5525
5550
5560
STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2008\SEPTEMBER 2008 GW.DWG

RECEIVED
APR 08 2013
DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

3

Please i
foldout F


N
CLK-2
5470.40 FT GW ELEV
CLK-1
5473.74 FT GW ELEV
BSB-A5
5481.9 FT GW ELEV
BSB-A1
5493.92 FT GW ELEV
MBMG-2
5515.21 FT GW ELEV
BSB-A6
5502.35 FT GW ELEV
5480
5490
5500
5510
5520
CLARK TAILINGS
OLD BUTTE LANDFILL
LEGEND
CLK-1
MONIROTING WELL
CONTOUR
CONTOUR INTERVAL= 10'

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 2
OLD BSB MUNICIPAL LANDFILL
SITE/CLARK TAILINGS FACILITY
SEPTEMBER 2008

SCALE: 1"=600'
DATE: 12/2/08

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2008\SEPTEMBER 2008 GW.DWG

RECEIVED
APR 08 2013
DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

[redacted] Closed

County Silver Bow

Facility & # Butte-Silver Bow #20

Closure

Finan Assur

GW Corr Meas

GW Monitoring

[✓ GW Reports]

Inspections

Other: ______________________

Landfarm

Liner

Methane

O & M

Run-on

Montana Department of
ENVIRONMENTAL QUALITY **MEMO**

TO:	Solid Waste Files Closed\Silver Bow Co.\Butte-Silver Bow County Landfill\Lic. #20\Groundwater Reports
FROM:	Martin Van Oort, Hydrogeologist – Solid Waste Section
DATE:	May 2, 2013
SUBJECT:	**Summary of Groundwater Monitoring at the closed Butte-Silver Bow County Landfill, License #20**

Groundwater monitoring at the closed Butte-Silver Bow County Landfill began in 1993 and VOC contamination was detected in down gradient monitoring wells during the first sampling event. A corrective measures assessment was initiated in 1995 and completed in 1997. The selected corrective measures of capping and passive landfill gas venting were implemented in 1997 and 1998. Because of historic mining related contamination, all groundwater down gradient from the facility is part of a controlled groundwater area which prohibits domestic water use.

The situation at this facility is unique because the closure of the facility was conducted jointly with a Superfund repository for the adjacent Clark Tailings. Because the boundary between the landfill waste and the tailings was undefined, both facilities were covered with a single cap. Two set of monitoring wells are present at the site: BSB designated wells monitor the landfill where VOCs are the contaminants of concern and CLK designated wells monitor the tailings where metals are the contaminants of concern.

Since the implementation of the corrective measures, the only VOC which has exceeded groundwater protection standards is Vinyl chloride at well BSB-A6R. Vinyl chloride concentrations at this well have varied over time, but do not show any discernible trends. Other VOCs in BSB-A6R have shown mixed trends, with some parameters increasing, some decreasing, and some stable. From 2005 to 2011 increasing VOC trends were noted in well BSB-A5, but concentrations decreased in 2012. Arsenic and Cadmium have exceeded groundwater protection standards in well CLK-1, which has been attributed to the tailings not the landfill.

(Closed)

County Silver-Bow #20

Facility & # Old Butte-Silver Bow

Closure
Finan Assur
GW Corr Meas
GW Monitoring
[✓ GW Reports]
Inspections
Other: ____________________

Landfarm
Liner
Methane
O & M
Run-on

PIONEER
TECHNICAL SERVICES, INC.

P.O Box 3445, Butte, MT 59702
www.pioneer-technical.com

April 7, 2008

Mary Louise Hendrickson
Montana Dept. of Environmental Quality
Solid Waste Regulatory Program
P.O. Box 200901
Helena, MT 59620-0901

Dear Ms. Hendrickson:

Enclosed please find two (2) copies of the Old Butte-Silver Bow Municipal Landfill/Clark Tailings Facility Draft Sampling and Analysis Plan (SAP). Upon a recent review of our files, we discovered that this updated SAP had not been submitted to you. The Draft SAP has been followed for the last 3 sampling events at the Old Landfill, including: March 2007; September 2007; and March 2008. Please accept our apologies for this oversight. If you have questions or comments you can contact Shawn Bisch at 406-563-9371, Brad Hollamon at 406-490-7678 or Julie Flammang at 406-498-0628.

Sincerely,

Julie Flammang

Julie Flammang
Sr. Scientist

Enclosures

cc: Brad Hollamon
Shawn Bisch

Special Resource Management INC.
A Subsidiary of Chemical Waste Management, Inc.
printed on recycled paper

Job No. ________ Sheet ____ of ____
Client BSB - OLD Landfill
Design by: ________
Project ________
Date: ________
Checked by: ________
Date: ________

Pat,

Here are the well Logs & Info for the old Landfill. They are not complete because BSB has not given us approval for any additional work. All Info is here, logs are not completily filled out.

Dave E

RECEIVED
MAY 05 1994
MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES
AND HAZARDOUS WASTE BUREAU
RC

State of Montana
Department of Health
and Environmental Sciences

Route to: Solid Waste ☐

MONITORING WELL CONSTRUCTION

Facility/Project Name: Old Butte Silver Bow Landfill

Facility License

Type of Well: Water Table Observation Well ☑ 11   Piezometer ☐ 12

Distance Well Is From Waste/Source Boundary ______ ft

Is Well a Point of Standards Application? ☐ Yes ☐ No

Local Grid Location of Well ______ ft ☐ N ☐ S ______ ft ☐ E ☐ W

Grid Origin Location

Lat. ___ ___ ___ Long. ___ ___ ___ or

St. Plane ______ ft N ______ ft S

Section Location of Waste/Source ☐ E ☐ W

Location of Well Relative to Waste/Source

u ☐ Upgradient   s ☐ Sidegradient

d ☐ Downgradient   n ☐ Not Known

Well Name: BSB-A1

MT Unique Well Number   DHES Well Name

Date Well Installed: 03/23/93 (mm dd yy)

Well Installed By: (Person's Name and Firm) D. Erickson SRM

Monitoring Well Constructor License Number

A. Protective pipe, top elevation ______ ft. MSL

B. Well casing, top elevation ______ ft. MSL

C. Land Surface elevation ______ ft. MSL

D. Surface seal, bottom ______ ft. MSL or ______ ft.

12. USCS classification of soil near screen:

GP ☐ GM ☐ GC ☐ GW ☐ GW ☐ SP ☐

SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐

Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐

Hollow Stem Auger ☑

Other ☐ ______

15. Drilling fluid used: Water ☐ Air ☐

Drilling Mud ☐ None ☑

16. Drilling additives used? ☐ Yes ☑ No

Describe ______

17. Source of water: ______

E. Bentonite seal, top ______ ft. MSL or ______ ft.

F. Fine sand, top ______ ft. MSL or ______ ft.

G. Filter pack, top ______ ft. MSL or ______ ft.

H. Screen joint, top ______ ft. MSL or ______ ft.

I. Well bottom ______ ft. MSL or ______ ft.

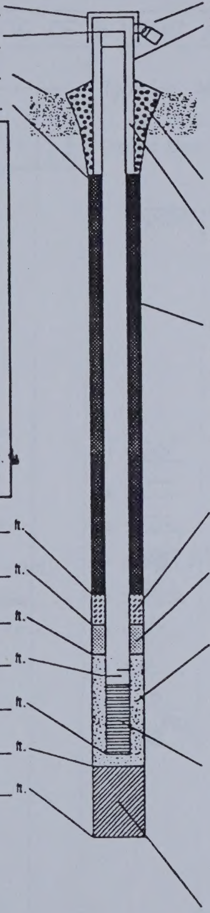
J. Filter pack, bottom ______ ft. MSL or ______ ft.

K. Borehole bottom ______ ft. MSL or ______ ft.

L. Borehole, diameter ______ in.

M. O.D. well casing ______ in.

N. I.D. well casing ______ in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:

a. Inside diameter: 6.0 in.

b. Length: 5.0 ft.

c. Material: Steel ☑ Other ☐ ______

d. Additional protection? ☐ Yes ☐

If yes, describe: ______

3. Surface seal: Bentonite ☐ Concrete ☑ Other ☐ ______

4. Material between well casing and protective pipe:

Bentonite ☑

Annular space seal ☐

Other ☐ ______

5. Annular space seal: a. Granular bentonite ☑

b. ______ Lbs/gal mud weight . . . Bentonite-sand slurry ☐

c. ______ Lbs/gal mud weight . . . Bentonite slurry ☐

d. ______ % bentonite . . . . Bentonite cement grout ☐

e. ______ Ft^3 volume added for any of the above

f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☑

6. Bentonite seal: a. Bentonite granules ☐

b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2. Bentonite pellets ☑

c. ______ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size

a. 10-20 Colorado Silica

b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size

a. Same as 7

b. Volume added ______ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☑

Flush threaded PVC schedule 80 ☐

Other ☐ ______

10. Screen material: PVC Sch 40

a. Screen type: Factory cut ☑ Continuous slot ☐ Other ☐ ______

b. Manufacturer: Enviro Well Products

c. Slot size: 0.020 in.

d. Slotted length: ______ ft.

11. Backfill material: ______ None ☑

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature

Firm

SPECIAL RESOURCE MANAGEMENT
GROUNDWATER WELL INSTALLATION REPORT

Well No. BSB-A1

Project BSB Old Landfill
Location
Project No.
Installed By
Date
Time
Method of Installation

LOG OF BORING AND WELL

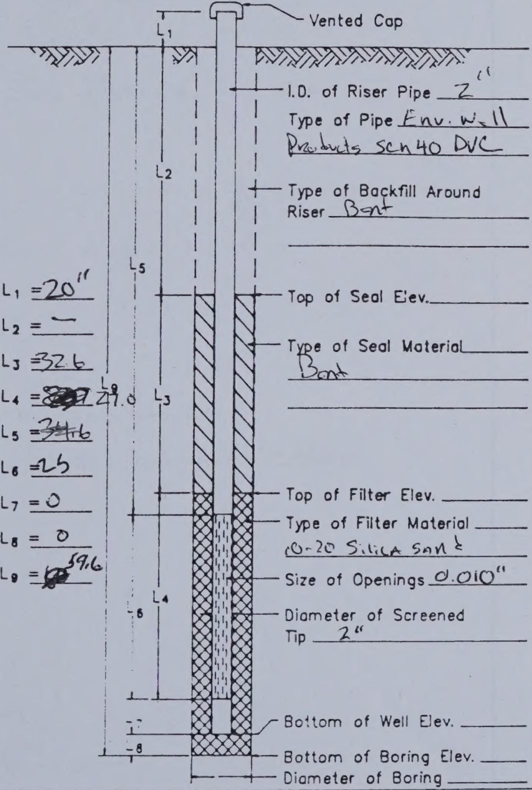
BORING

Depth In ft.	Description	H-Nu Reading
	SEAL	
	SANDPACK	
	~~SEAL~~	
	SCREEN	
	7d 9bg Bont 11 bgs	

OBSERVATION WELL INFORMATION

Type of WELL Monitoring

Ground Elev.
Top of Riser Elev.



L1 = 20"
L2 = –
L3 = 32.6
L4 = ~~[illegible]~~ 27.0
L5 = 34.6
L6 = 25
L7 = 0
L8 = 0
L9 = ~~60~~ 59.6

I.D. of Riser Pipe 2"
Type of Pipe Env. Well Products sch 40 PVC
Type of Backfill Around Riser Bent
Top of Seal Elev.
Type of Seal Material Bent
Top of Filter Elev.
Type of Filter Material 10-20 Silica Sand
Size of Openings 0.010"
Diameter of Screened Tip 2"
Bottom of Well Elev.
Bottom of Boring Elev.
Diameter of Boring

Remarks

Prepared By

State of Montana - Department of Health and Environmental Sciences

SOIL BORING LOG INFORMATION

Project Name Old Butte-Silver Bow Landfill Boring No. BSB-A1

Project No: 31-976-02 Logger's Name D. Erickson Date 3/23/93

___ 1/4 of ___ 1/4 of Section ___ T___ N, R___ E or W ___ Grid Location (if applicable): ___ feet W or S ___ feet E or W

Well diameter _____ Surface elevation: _____ MT unique well number: _____

Method of Advance: Auger to 60 Wash to _____

Free Water Encountered: Yes ☑ No ☐ at 47 ft.

DEPTH	SAMPLE	SYMBOL	HNU PPM	Recovery %	BLOWS PER FOOT	
	Continous Core			100%		Md Brn Sandy Loam
				65		Orange brn fn sd Tailings
5						
				100		Orange silty sand
				50		Same with grey plastic Clay layers 1" thick
10						
				90		Dk brn Silty Clayey Sand
						Same Sand at Botom
				100		
15						
				20		red brn silty Sand Little Clay and mica
				60		Same
20						
				0		
				75		Lt Brn silty Sand damp
25						
				75		Same
				100		Same brn clay Red silty sand
30						
				100		grey silt with Red sand streaks
				60		grey silty Clay with Red silty sand streaks
35						
						Same
40						
						Same wet
45						
						grey silty Clay md brn Vcrs Sand Grey silty Clay Plastic soft Crs Sand + Silt
50						

BLOW PER FOOT	DESCRIPTIVE TERM
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Firm
31 - 50	Dense
OVER 50	Very Dense

POCKET PEN.	DESCRIPTIVE TERM
Less than 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Medium
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
4.00 and higher	Hard

Time	Depth to Water	Time	Depth to Water

State of Montana - Department of Health and Environmental Sciences

SOIL BORING LOG INFORMATION

Project Name Old Butte-Silver Bow Landfill

Boring No. BSB-A1

Project No: 31-976-02

Logger's Name D. Erickson

Date ______

___ 1/4 of ___ 1/4 of Section ___ T___ N, R ___ E or W ___ Grid Location (if applicable): ___ feet W or S ___ feet E or W

Well diameter _____ Surface elevation: _____ MT unique well number: _____

Method of Advance: Auger to _____ Wash to _____

Free Water Encountered: Yes ☑ No ☐ at _____

DEPTH	SAMPLE	SYMBOL	HNU PPM	RECOVERY %	BLOWS PER FOOT	
	Continuous Core					Lt gray silty Sand, mica, gravel
55						
						Hard silty Sand Angular Vcrs
						Granite Bedrock
60						TD 60' Refusal

BLOW PER FOOT	DESCRIPTIVE TERM
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Firm
31 - 50	Dense
OVER 50	Very Dense

POCKET PEN.	DESCRIPTIVE TERM
Less than 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Medium
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
4.00 and higher	Hard

Time	Depth to Water	Time	Depth to Water

State of Montana
Department of Health
and Environmental Sciences

Route Solid Waste ☐

MONITORING WELL DEVELOPMENT

Facility/Project Name	County Name	Well Name MW - A1
Facility License Number	County Code	MT Unique Well Number / DHES Well Number
Well Installed By: (Person's Name and Firm)		Monitoring Well Constructor License Number

1. Can this well be purged dry? ☐ Yes ☑ No

2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☐
   - pumped only ☐
   - pumped slowly ☐
   - Other hand pumped - purged ☑

3. Time spent developing well ____ min.

4. Depth of well (from top of casing) ft. 56.5 ft

5. Inside diameter of well 2.0 in.

casing volume 2.0 gal

6. Volume of water in filter pack and well casing 22.2 gal.

7. Volume of water removed from well 10.0 gal.

8. Volume of water added (if any) — gal.

9. Source of water added ________

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 41.63 ft	___.__ ft.
Date	b. 04/01/93 (mm dd yy)	__/__/__ (mm dd yy)
Time	c. 09:30 ☑ a.m. ☐ p.m.	__:__ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	__.__ inches	__.__ inches
13. Water clarity	Clear ☐ Turbid ☑ (Describe)	Clear ☐ Turbid ☐ (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	_____.__ mg/l	_____.__ mg/l
15. COD	_____.__ mg/l	_____.__ mg/l

16. Additional comments on development

pH = 7.5

cond = 778 µS

Well developed by: (Person's Name and Firm)

Name: ________

Firm: ________

I hereby certify that the above information is true and correct to the best of my knowledge

Signature:

Print Initials: PLC

Firm: SCM

Note: Shaded areas are for DHES use only. See instructions for more information including a list of county codes.

State of Montana
Department of Health
and Environmental Sciences

Route to: S Waste ☐

MONITORING WELL CONSTRUCTION

Facility/Project Name: Old Butte Silver Bow Landfill

Facility License: ____

Type of Well: Water Table Observation Well ☑ 11 Piezometer ☐ 12

Distance Well Is From Waste/Source Boundary ____ ft

Is Well a Point of Standards Application? ☐ Yes ☐ No

Local Grid Location of Well ____ ft ☐ N ☐ S ____ ft ☐ E ☐ W

Grid Origin Location

Lat. ____ ____ ____ Long. ____ ____ ____ or

St. Plane ____ ft N ____ ft S

Section Location of Waste/Source ☐ E ☐ W

Location of Well Relative to Waste/Source

u ☐ Upgradient s ☐ Sidegradient

d ☐ Downgradient n ☐ Not Known

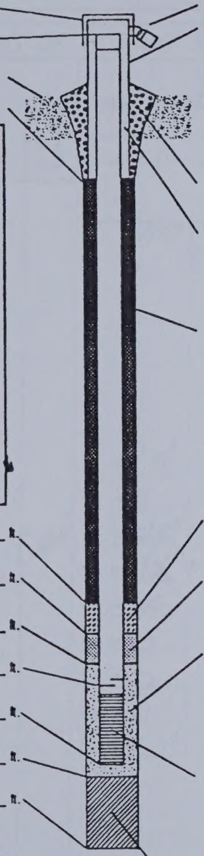
Well Name: BSB-A2

MT Unique Well Number DHES Well Name

Date Well Installed __/__/__ (mm dd yy)

Well Installed By: (Person's Name and Firm) D. Erickson SRM

Monitoring Well Constructor License Number



A. Protective pipe, top elevation ____.__ ft. MSL

B. Well casing, top elevation ____.__ ft. MSL

C. Land Surface elevation ____.__ ft. MSL

D. Surface seal, bottom ____.__ ft. MSL or ___.__ ft.

12. USCS classification of soil near screen:

GP ☐ GM ☐ GC ☐ GW ☐ GW ☐ SP ☐

SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐

Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ Hollow Stem Auger ☑ Other ☐ ____

15. Drilling fluid used: Water ☐ Air ☐ Drilling Mud ☐ None ☑

16. Drilling additives used? ☐ Yes ☑ No

Describe ____

17. Source of water: ____

E. Bentonite seal, top ____.__ ft. MSL or ____.__ ft.

F. Fine sand, top ____.__ ft. MSL or ____.__ ft.

G. Filter pack, top ____.__ ft. MSL or ____.__ ft.

H. Screen joint, top ____.__ ft. MSL or ____.__ ft.

I. Well bottom ____.__ ft. MSL or ____.__ ft.

J. Filter pack, bottom ____.__ ft. MSL or ____.__ ft.

K. Borehole bottom ____.__ ft. MSL or ____.__ ft.

L. Borehole, diameter ___.__ in.

M. O.D. well casing ___.__ in.

N. I.D. well casing ___.__ in.

1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:

a. Inside diameter: 6.0 in.

b. Length: 5.0 ft.

c. Material: Steel ☑ Other ☐ ____

d. Additional protection? ☐ Yes ☐

If yes, describe: ____

3. Surface seal: Bentonite ☐ Concrete ☑ Other ☐ ____

4. Material between well casing and protective pipe: Bentonite ☑ Annular space seal ☐ Other ☐ ____

5. Annular space seal: a. Granular bentonite ☑

b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐

c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐

d. ____ % bentonite . . . . Bentonite cement grout ☐

e. ____ Ft^3 volume added for any of the above

f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☑

6. Bentonite seal: a. Bentonite granules ☐

b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2. Bentonite pellets ☑

c. ____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size

a. 10-20 Colorado Silica

b. Volume added ____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size

a. SAME AS 7

b. Volume added ____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☑ Flush threaded PVC schedule 80 ☐ Other ☐ ____

10. Screen material: PVC Sch 40

a. Screen type: Factory cut ☑ Continuous slot ☐ Other ☐ ____

b. Manufacturer: Enviro Well Products

c. Slot size: 0.020 in.

d. Slotted length: __.__ ft.

11. Backfill material: ____ None ☑

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature ____ Firm ____

SPECIAL RESOURCE MANAGEMENT
GROUNDWATER WELL INSTALLATION REPORT

Well No. BSB-W2

Project ______ Location ______

Project No. ______ Installed By ______ Date ______ Time ______

Method of Installation ______

LOG OF BORING AND WELL

BORING

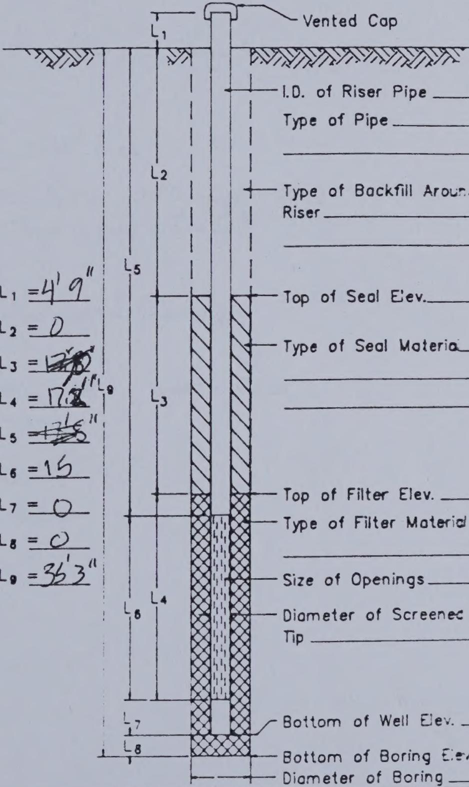
Depth In ft.	Description	H-Nu Reading
	35 3 17 8	
	B#10 17.8 7.2	

18' 1" ~~1'10"~~

OBSERVATION WELL INFORMATION

Type of WELL ______

Ground Elev. ______ Top of Riser Elev. ______



Vented Cap

I.D. of Riser Pipe ______

Type of Pipe ______

Type of Backfill Around Riser ______

Top of Seal Elev. ______

Type of Seal Material ______

Top of Filter Elev. ______

Type of Filter Material ______

Size of Openings ______

Diameter of Screened Tip ______

Bottom of Well Elev. ______

Bottom of Boring Elev. ______

Diameter of Boring ______

L1 = 4' 9"
L2 = 0
L3 = ~~12'0~~
L4 = 17'2"
L5 = ~~13'5"~~ 1'6"
L6 = 15
L7 = 0
L8 = 0
L9 = 35'3"

Remarks ______

Prepared By ______

State of Montana - Department of Health and Environmental Sciences

SOIL BORING LOG INFORMATION

Project Name Old Butte-Silver Bow Landfill Boring No. BSB-A2

Project No: 31-976-02 Logger's Name D. Erickson Date 3/25/93

___ 1/4 of ___ 1/4 of Section ___ T___ N, R___ E or W ___ Grid Location (if applicable): ___ feet W or S ___ feet E or W

Well diameter ______ Surface elevation: ______ MT unique well number: ______

Method of Advance: Auger to 35' 3" Wash to ______

Free Water Encountered: Yes ☑ No ☐ at 30'

DEPTH	SAMPLE	SYMBOL	HNU PPM	RECOVERY %	BLOWS PER FOOT	
	Continuous Core			75		md brn Sandy Loan TAILINGS
				50		Lt grey silt with orange streaks
5				75		
				60		
10				60		
				80		Lt Brn Sand (fn-Vcrs) Clay+Silt lens
15				0		
						SAME
				100		md Grey Clayey silt mica
20				100		Alternating Layers ½-1' Silty clayes sand and Lt grey clean sand rounded mica
				100		
25				60		Wet Orange-Yellow sand (fn-Vcrs)
				60		
30				80		29'-30'. Red-brn stain sweet Odor md brn Silty sand
				100		
35						Weathered granite TD 35' 3" Refusal

BLOW PER FOOT	DESCRIPTIVE TERM
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Firm
31 - 50	Dense
OVER 50	Very Dense

POCKET PEN.	DESCRIPTIVE TERM
Less than 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Medium
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
4.00 and higher	Hard

Time	Depth to Water	Time	Depth to Water

State of Montana
Department of Health
and Environmental Sciences

Route Solid Waste ☐

# MONITORING WELL DEVELOPMENT

Facility/Project Name	County Name	Well Name MW-17R
Facility License Number	County Code	MT Unique Well Number
		DHES Well Number
Well Installed By: (Person's Name and Firm)		Monitoring Well Constructor License Number

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☐
   - pumped only ☐
   - pumped slowly ☐
   - Other hand pumped-purged ☑

3. Time spent developing well 20 min.

4. Depth of well (from top of casing) 39.0 ~~80.2~~ ft.

5. Inside diameter of well 2.0 in.

volume in casing 1.2 gal

6. Volume of water in filter pack and well casing 17.4 gal.

7. Volume of water removed from well 10.0 gal.

8. Volume of water added (if any) — gal.

9. Source of water added ____

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

		Before Development	After Development
11. Depth to Water (from top of well casing)	a.	30.00 ft.	__ . __ ft.
Date	b.	03/31/93 (mm dd yy)	__/__/__ (mm dd yy)
Time	c.	2:00 ☐ a.m. ☑ p.m.	__:__ ☐ a.m. ☐ p.m.
12. Sediment in well bottom		__ . __ inches	__ . __ inches
13. Water clarity		Clear ☐ Turbid ☑ (Describe)	Clear ☐ Turbid ☐ (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

	Before Development	After Development
14. Total suspended solids	__ . __ mg/l	__ . __ mg/l
15. COD	__ . __ mg/l	__ . __ mg/l

16. Additional comments on development

pH = 6.9 @ 11.7°C
cond = 1410 us

Well developed by: (Person's Name and Firm)	I hereby certify that the above information is true and correct to the best of my knowledge
Name:	Signature:
Firm:	Print Initials: PLC
	Firm: SRM

Note: Shaded areas are for DHES use only. See instructions for more information including a list of county codes.

State of Montana
Department of Health
and Environmental Sciences

Route to: Solid Waste ☐

MONITORING WELL CONSTRUCTION

Facility/Project Name: Old Butte Silver Bow Landfill

Facility License

Local Grid Location of Well ______ ft ☐ N ☐ S ______ ft ☐ E ☐ W

Grid Origin Location

Lat. ______ Long. ______ or

St. Plane ______ ft N ______ ft S

Section Location of Waste/Source ☐ E ☐ W

Well Name: BSB- A3

MT Unique Well Number / DHES Well Name

Date Well Installed __/__/__ (mm dd yy)

Well Installed By: (Person's Name and Firm) D. Erickson SRM

Monitoring Well Constructor License Number

Type of Well: Water Table Observation Well ☑ 11 Piezometer ☐ 12

Distance Well Is From Waste/Source Boundary ______ ft

Is Well a Point of Standards Application? ☐ Yes ☐ No

Location of Well Relative to Waste/Source: u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known

A. Protective pipe, top elevation ____.__ ft. MSL

B. Well casing, top elevation ____.__ ft. MSL

C. Land Surface elevation ____.__ ft. MSL

D. Surface seal, bottom ____.__ ft. MSL or ____.__ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ GW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ Hollow Stem Auger ☑ Other ☐ ______

15. Drilling fluid used: Water ☐ Air ☐ Drilling Mud ☐ None ☑

16. Drilling additives used? ☐ Yes ☑ No

Describe ______

17. Source of water: ______

E. Bentonite seal, top ____.__ ft. MSL or ____.__ ft.

F. Fine sand, top ____.__ ft. MSL or ____.__ ft.

G. Filter pack, top ____.__ ft. MSL or ____.__ ft.

H. Screen joint, top ____.__ ft. MSL or ____.__ ft.

I. Well bottom ____.__ ft. MSL or ____.__ ft.

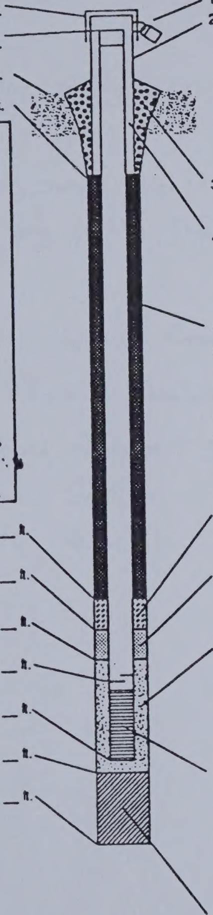
J. Filter pack, bottom ____.__ ft. MSL or ____.__ ft.

K. Borehole bottom ____.__ ft. MSL or ____.__ ft.

L. Borehole, diameter ____.__ in.

M. O.D. well casing ____.__ in.

N. I.D. well casing ____.__ in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:
   a. Inside diameter: 6.0 in.
   b. Length: 5.0 ft.
   c. Material: Steel ☑ Other ☐ ______
   d. Additional protection? ☐ Yes ☐ No
   If yes, describe: ______

3. Surface seal: Bentonite ☐ Concrete ☑ Other ☐ ______

4. Material between well casing and protective pipe: Bentonite ☑ Annular space seal ☐ Other ☐ ______

5. Annular space seal:
   a. Granular bentonite ☑
   b. ______ Lbs/gal mud weight . . . Bentonite-sand slurry ☐
   c. ______ Lbs/gal mud weight . . . Bentonite slurry ☐
   d. ______ % bentonite . . . . Bentonite cement grout ☐
   e. ______ Ft^3 volume added for any of the above
   f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☑

6. Bentonite seal:
   a. Bentonite granules ☐
   b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2. Bentonite pellets ☑
   c. ______ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
   a. 10-20 Colorado Silica
   b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
   a. Same as 7
   b. Volume added ______ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☑ Flush threaded PVC schedule 80 ☐ Other ☐ ______

10. Screen material: PVC Sch 40
   a. Screen type: Factory cut ☑ Continuous slot ☐ Other ☐ ______
   b. Manufacturer: Enviro Well Products
   c. Slot size: 0.020 in.
   d. Slotted length: __.__ ft.

11. Backfill material: ______ None ☑

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature ______ Firm ______

State of Montana - Department of Health and Environmental Sciences

SOIL BORING LOG INFORMATION

Project Name Old Butte-Silver Bow Landfill Boring No. BSB-A3

Project No: 31-976-02 Logger's Name D. Erickson Date 3/25/93

___ 1/4 of ___ 1/4 of Section ___ T___ N, R___ E or W ___ Grid Location (if applicable): ___ feet W or S ___ feet E or W

Well diameter ______ Surface elevation: ______ MT unique well number: ______

Method of Advance: Auger to 29.5 Wash to ______

Free Water Encountered: Yes ☑ No ☐ at 29.0

DEPTH	SAMPLE	SYMBOL	HNU PPM	RECOVERY %	BLOWS PER FOOT	
	Continous Core				100	md Brn Silty Loam Tailings
					100	Yellow silt
5						
					100	
					40	mD Brn Silty Sand w/clay
10						
					40	
						Dk Grey sand mica
					100	
15						Black slag with Quartz gravel
					100	
					100	
20					100	Slightly Weathered Granite
						Damp Vertical fractures
					100	
25						Weathered feldspars - green blue soft clay/silt
					100	
					100	Weathered Granite
						TD - 29.5' Refusal

BLOW PER FOOT	DESCRIPTIVE TERM
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Firm
31 - 50	Dense
OVER 50	Very Dense

POCKET PEN.	DESCRIPTIVE TERM
Less than 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Medium
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
4.00 and higher	Hard

Time	Depth to Water	Time	Depth to Water

SPECIAL RESOURCE MANAGEMENT
GROUNDWATER WELL INSTALLATION REPORT

Well No. BSB-W3

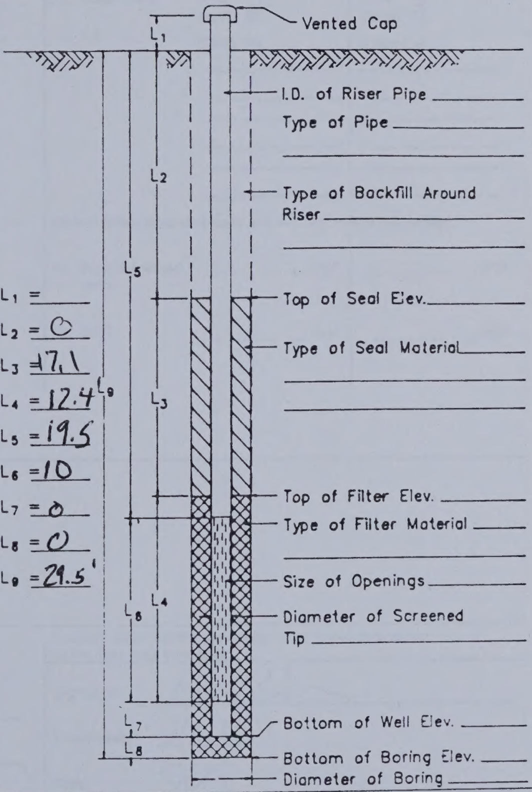
Project ______ Location ______

Project No. ______ Installed By DJE Date 3/26 Time 1058

Method of Installation ______

LOG OF BORING AND WELL

BORING			OBSERVATION WELL INFORMATION
Depth in ft.	Description	H-Nu Reading	Type of WELL ______
	29.5 12.4 171		Ground Elev. ______ Top of Riser Elev. ______



L1 = ______

L2 = 0

L3 = 17.1

L4 = 12.4

L5 = 19.5

L6 = 10

L7 = 0

L8 = 0

L9 = 29.5'

I.D. of Riser Pipe ______

Type of Pipe ______

Type of Backfill Around Riser ______

Top of Seal Elev. ______

Type of Seal Material ______

Top of Filter Elev. ______

Type of Filter Material ______

Size of Openings ______

Diameter of Screened Tip ______

Bottom of Well Elev. ______

Bottom of Boring Elev. ______

Diameter of Boring ______

Remarks ______

Prepared By ______

State of Montana
Department of Health
and Environmental Sciences

Route ☐ Solid Waste ☐

MONITORING WELL DEVELOPMENT

Facility/Project Name

County Name

Well Name MW-A3

Facility License Number ________

County Code __

MT Unique Well Number ______

DHES Well Number ___

Well Installed By: (Person's Name and Firm)

Monitoring Well Constructor License Number

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☑
   - pumped only ☐
   - pumped slowly ☐
   - Other ________ ☐

3. Time spent developing well 10 min.

4. Depth of well (from top of casing) 39.9 ft.

5. Inside diameter of well 2.0 in.

casing volume .12 gal

6. Volume of water in filter pack and well casing 1.2 gal.

7. Volume of water removed from well 5 gal.

8. Volume of water added (if any) — gal.

9. Source of water added ________

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 24.04 ft.	___.__ ft.
Date	b. 04/01/93 mm dd yy	__/__/__ mm dd yy
Time	c. 09:00 ☑ a.m. ☐ p.m.	__:__ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	__.__ inches	__.__ inches
13. Water clarity	Clear ☐ Turbid ☑ (Describe)	Clear ☐ Turbid ☐ (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	_____._ mg/l	_____._ mg/l
15. COD	_____._ mg/l	_____._ mg/l

16. Additional comments on development

pH = 7.4
cond = 1402 uS

Well developed by: (Person's Name and Firm)

Name: ________

Firm: ________

I hereby certify that the above information is true and correct to the best of my knowledge

Signature:

Print Initials: PLC

Firm: SRM

Note: Shaded areas are for DHES use only. See instructions for more information including a list of county codes.

State of Montana
Department of Health
and Environmental Sciences

Route to: Solid Waste ☐

MONITORING WELL CONSTRUCTION

Facility/Project Name: Old Bute Silver Bow Landfill

Facility License

Type of Well: Water Table Observation Well ☑ 11 Piezometer ☐ 12

Distance Well Is From Waste/Source Boundary ____ ft

Is Well a Point of Standards Application? ☐ Yes ☐ No

Local Grid Location of Well ______ ft ☐ N ☐ S ______ ft ☐ E ☐ W

Grid Origin Location

Lat. ______ Long. ______ or

St. Plane ______ ft N ______ ft S

Section Location of Waste/Source ☐ E ☐ W

Location of Well Relative to Waste/Source

u ☐ Upgradient s ☐ Sidegradient

d ☐ Downgradient n ☐ Not Known

Well Name: BSB-A4

MT Unique Well Number | DHES Well Name

Date Well Installed __/__/__ (mm dd yy)

Well Installed By: (Person's Name and Firm) D. Erickson SRM

Monitoring Well Constructor License Number

A. Protective pipe, top elevation ____.__ ft. MSL

B. Well casing, top elevation ____.__ ft. MSL

C. Land Surface elevation ____.__ ft. MSL

D. Surface seal, bottom ____.__ ft. MSL or ____.__ ft.

12. USCS classification of soil near screen:

GP ☐ GM ☐ GC ☐ GW ☐ GW ☐ SP ☐

SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐

Bedrock ☐

13. Sieve analysis attached? ☐ Yes ☑ No

14. Drilling method used: Rotary ☐ Hollow Stem Auger ☑ Other ☐

15. Drilling fluid used: Water ☐ Air ☐ Drilling Mud ☐ None ☑

16. Drilling additives used? ☐ Yes ☑ No

Describe ______

17. Source of water: ______

E. Bentonite seal, top ____.__ ft. MSL or ____.__ ft.

F. Fine sand, top ____.__ ft. MSL or ____.__ ft.

G. Filter pack, top ____.__ ft. MSL or ____.__ ft.

H. Screen joint, top ____.__ ft. MSL or ____.__ ft.

I. Well bottom ____.__ ft. MSL or ____.__ ft.

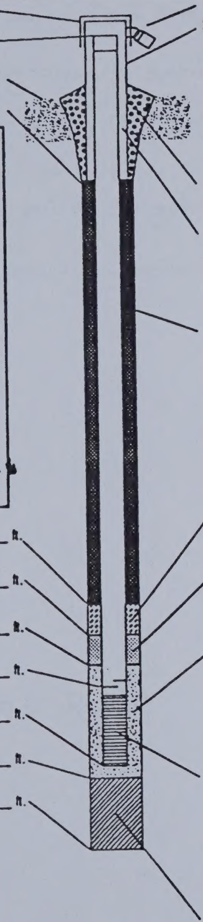
J. Filter pack, bottom ____.__ ft. MSL or ____.__ ft.

K. Borehole bottom ____.__ ft. MSL or ____.__ ft.

L. Borehole, diameter ____.__ in.

M. O.D. well casing ____.__ in.

N. I.D. well casing ____.__ in.



1. Cap and lock? ☑ Yes ☐ No

2. Protective cover pipe:

a. Inside diameter: 6.0 in.

b. Length: 5.0 ft.

c. Material: Steel ☑ Other ☐

d. Additional protection? ☐ Yes ☐

If yes, describe: ______

3. Surface seal: Bentonite ☐ Concrete ☑ Other ☐

4. Material between well casing and protective pipe: Bentonite ☑ Annular space seal ☐ Other ☐

5. Annular space seal: a. Granular bentonite ☑

b. ____ Lbs/gal mud weight . . . Bentonite-sand slurry ☐

c. ____ Lbs/gal mud weight . . . Bentonite slurry ☐

d. ____ % bentonite . . . . Bentonite cement grout ☐

e. ____ Ft^3 volume added for any of the above

f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☑

6. Bentonite seal: a. Bentonite granules ☐

b. ☐ 1/4 in. ☑ 3/8 in. ☐ 1/2 Bentonite pellets ☑

c. ______ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size

a. 10-20 Colorado Silica

b. Volume added ______ ft^3

8. Filter pack material: Manufacturer, product name & mesh size

a. Same as 7

b. Volume added ______ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☑ Flush threaded PVC schedule 80 ☐ Other ☐

10. Screen material: PVC Sch 40

a. Screen type: Factory cut ☑ Continuous slot ☐ Other ☐

b. Manufacturer: Enviro Well Products

c. Slot size: 0.020 in.

d. Slotted length: __.__ ft.

11. Backfill material: None ☑

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature | Firm

State of Montana - Department of Health and Environmental Sciences

SOIL BORING LOG INFORMATION

Project Name Old Butte-Silver Bow Landfill Boring No. BSB-A4

Project No: 31-976-02 Logger's Name D. Erickson Date 3/26

___ 1/4 of ___ 1/4 of Section ___ T___ N, R___ E or W ___ Grid Location (if applicable): ___ feet W or S ___ feet E or W

Well diameter _____ Surface elevation: _____ MT unique well number: _____

Method of Advance: Auger to _____ Wash to _____

Free Water Encountered: Yes ☑ No ☐ at 34'

DEPTH	SAMPLE	SYMBOL	HNU PPM	RECOVERY %	BLOWS PER FOOT	
	Continuous Core					Lt Brn Silty Sand
						Grey Sd and mica
5						Finely Layered Grey silt mica
						Lt grey granite sand mica
10						Md Brn silty Sand with layers subangular Crs granite sd
						Layers of Lt Brn Silty sd and grey Crs granite sd with mica + granite gravel
15						
						↓ Increasing granite sand
20						
25						
30						
						Water
35						
						TD - 37.5 Refusal

BLOW PER FOOT	DESCRIPTIVE TERM
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Firm
31 - 50	Dense
OVER 50	Very Dense

POCKET PEN.	DESCRIPTIVE TERM
Less than 0.25	Very Soft
0.25 to 0.50	Soft
0.50 to 1.00	Medium
1.00 to 2.00	Stiff
2.00 to 4.00	Very Stiff
4.00 and higher	Hard

Time	Depth to Water	Time	Depth to Water

MONITORING WELL DEVE[illegible]MENT

Well Name MW-A4

T Unique Well Number _ _ _ _ _ _

DHES Well Number _ _ _

nitoring Well Constructor License Number

	Before Development	After Development
pth to Water n top of casing)	a. 28.35 ft.	_ _ _ . _ _ ft.
	b. 04/01/93 mm dd yy	_ _ / _ _ / _ _ mm dd yy
	c. 12:00 ☐ a.m. ☒ p.m.	_ _ : _ _ ☐ a.m. ☐ p.m.
diment in well ttom	_ _ . _ inches	_ _ . _ inches
ater clarity	Clear ☐ Turbid ☒ (Describe)	Clear ☐ Turbid ☐ (Describe)

drilling fluids were used and well is at solid waste facility:

tal suspended lids	_ _ _ _ _ . _ mg/l	_ _ _ _ _ . _ mg/l
DD	_ _ _ _ _ . _ mg/l	_ _ _ _ _ . _ mg/l

y certify that the above information is true and correct
best of my knowledge

ure:

itials: PLC

SRM

luding a list of county codes.

Name

Code

No

No

ore information including a list of county codes.

MONITORING WELL DEVELOPMENT

Well Name MBM61

MT Unique Well Number _ _ _ _ _ _

DHES Well Number _ _ _

Monitoring Well Constructor License Number

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 13.02 ft.	_ _ _ . _ _ ft.
Date	b. 04/01/93 mm dd yy	_ _ / _ _ / _ _ mm dd yy
Time	c. 2:00 ☐ a.m. ☒ p.m.	_ _ : _ _ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	_ _ . _ inches	_ _ . _ inches
13. Water clarity	Clear ☐ Turbid ☐ (Describe)	Clear ☐ Turbid ☐ (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	_ _ _ _ _ . _ mg/l	_ _ _ _ _ . _ mg/l
15. COD	_ _ _ _ _ . _ mg/l	_ _ _ _ _ . _ mg/l

I hereby certify that the above information is true and correct
to the best of my knowledge

Signature:

Print Initials: PLC

Firm: SRM

State of Montana
Department of Health
and Environmental Sciences

Rout Solid Waste ☐

MONITORING WELL DEVELOPMENT

Facility/Project Name

County Name

Well Name MBMG2

Facility License Number

County Code

MT Unique Well Number

DHES Well Number

Well installed By: (Person's Name and Firm)

Monitoring Well Constructor License Number

1. Can this well be purged dry? ☐ Yes ☐ No

2. Well development method
   - surged with bailer and bailed ☐
   - surged with bailer and pumped ☐
   - surged with block and bailed ☐
   - surged with block and pumped ☐
   - surged with block, bailed and pumped ☐
   - compressed air ☐
   - bailed only ☑
   - pumped only ☐
   - pumped slowly ☐
   - Other ☐

3. Time spent developing well 15 min.

4. Depth of well (from top of casing) 24.9 ft.

5. Inside diameter of well 2.0 in.

Casing volume 1.5 gal

6. Volume of water in filter pack and well casing 20.9 gal.

7. Volume of water removed from well 5.0 gal.

8. Volume of water added (if any) ___.__ gal.

9. Source of water added

10. Analysis performed on water added? ☐ Yes ☐ No
(If yes, attach results)

	Before Development	After Development
11. Depth to Water (from top of well casing)	a. 14.08 ft.	___.__ ft.
Date	b. 04/01/93 mm dd yy	__/__/__ mm dd yy
Time	c. 2:30 ☐ a.m. ☑ p.m.	__:__ ☐ a.m. ☐ p.m.
12. Sediment in well bottom	___.__ inches	___.__ inches
13. Water clarity	Clear ☐ Turbid ☐ (Describe)	Clear ☐ Turbid ☐ (Describe)

Fill in if drilling fluids were used and well is at solid waste facility:

14. Total suspended solids	_____.__ mg/l	_____.__ mg/l
15. COD	_____.__ mg/l	_____.__ mg/l

16. Additional comments on development

pH = 7.3
Cond = 771 µS

Well developed by: (Person's Name and Firm)

Name:

Firm:

I hereby certify that the above information is true and correct to the best of my knowledge

Signature:

Print Initials: PLC

Firm: SRM

Note: Shaded areas are for DHES use only. See instructions for more information including a list of county codes.

Table 5.1.2 Well History Form

WELL HISTORY FORM

Page__of__

Well name: BSB-MW1

Location:

Project name:

No:

Task:

Well elevation:

Well Depth:

Ground Elevation:

Date Installed:

Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. ~~F~~ C	S.C. us	Comments
4/8/93	2:45	41.46			7.3	12.2	897	

Table 5.1.2 Well History Form

Page__of__

WELL HISTORY FORM

Well name: BS6-MW3
Location:
Project name:
No:
Task:
Well elevation:
Well Depth:
Ground Elevation:
Date Installed:
Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. ~~F~~ C	S.C.	Comments
4/8/13	5:00p	27.24			6.9	9.1	1355	

Table 5.1.2 Well History Form

Page__of__

WELL HISTORY FORM

Well name: BSB-MW4
Location:
Project name:
No:
Task:
Well elevation:
Well Depth:
Ground Elevation:
Date Installed:
Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. ~~F~~C	S.C.	Comments
4/8/93	2:15p	27.16			7.3	12.2	1585	

Table 5.1.2 Well History Form

Page__of__

WELL HISTORY FORM

Well name: MGM6-1

Location:

Project name:

No:

Task:

Well elevation:

Well Depth:

Ground Elevation:

Date Installed:

Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. ~~F~~ C	S.C.	Comments
4/8/93	9:00	13.34'			7.1	9.6	376	

Table 5.1.2 Well History Form

Page__of__

WELL HISTORY FORM

Well name: MBMG-2 Location:

Project name: No: Task:

Well elevation: Well Depth:

Ground Elevation:

Date Installed: Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. ~~F~~ C	S.C.	Comments
4/8/93	3:30p	12.85			7.2	10.3	776	

Table 5.1.2 Well History Form

Page 1 of 1

WELL HISTORY FORM

Well name: MBMG-3
Location:
Project name:
No:
Task:
Well elevation:
Well Depth: 20.4'
Ground Elevation:
Date Installed:
Screen Interval:

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. F	S.C.	Comments
4/8/93	3:00pm	5.18'			7.5		340	

File: Silver Bow Co - old Butte #20
grd wtr

Special Resource Management INC.

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June 29, 1993

RECEIVED
JUL 01 1993
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
[illegible] BUREAU

Pat Potts
MDHES-Solid Waste Program
Cogswell Building
Helena, MT 59620

RE: **Butte-Silver Bow, Silver Bow County - License No. 20, Ground Water Contour Map.**

Dear Pat,

Enclosed please find a map depicting ground water flow direction at the Butte-Silver Bow Landfill site. This map was constructed using data gathered during the installation of the BSB-A series wells, during which, contamination was found in wells BSB-A1, A2, and A3. SRM proposes to install additional monitoring wells to identify the extent of the contamination plume. The proposed wells are shown on the attached figure as BSB-B series wells and depicted as ○.

The well placement was selected based on three factors: 1) Groundwater flow direction, 2) Contaminant concentration, and 3) Bedrock topography. A justification for the placement of each well follows:

> BSB-B5. Placement was selected because of topographic low between BSB-A2 and BSB-A3. Also, Contaminant concentrations are highest in the area and topographic low on bedrock is expected.
>
> BSB-B6. Downgradient of highest contaminant concentrations. Water level information will better define the effect of bedrock topography on groundwater flow direction.
>
> BSB-B7. Furthest downgradient well on the landfill property.
>
> BSB-B8. Expected to be on the front edge of the plume - clean downgradient well. Located in right of way of county road.

Once these wells are installed, SRM will develop, sample, and conduct aquifer tests in each well. If you have any questions or comments, please contact me at 782-4201. We would like to install these well as soon as we receive your approval. Thank you for your timely consideration.

Sincerely,

David J. Erickson
Hydrogeologist

CC: Jason Handl, SRM

Mike Shea/ Jim Johnston
Public Works Department

:

RDINATES BASED ON NAD27 SO. ZONE

OF AERIAL PHOTOGRAPHY – 4/18/89

REFERENCE DRAWINGS	DRAWING NO.

Special Resource Management INC.

BUTTE–SILVER BOW
EXISTING AND PROPOSED
MONITORING WELL LOCATIONS

DRAWN	DESIGNED	APPROVED
WBA/ALW		

SCALE	PROJECT NO.	SIZE	SEQ.	DRAWING
1"=200'	31.00976.02	C		

Please inse
fold

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TE:

ORDINATES BASED ON NAD27 SO. ZONE

E OF AERIAL PHOTOGRAPHY – 4/18/89

CE DRAWINGS	DRAWING NO.

Special Resource Management INC.

BUTTE–SILVER BOW
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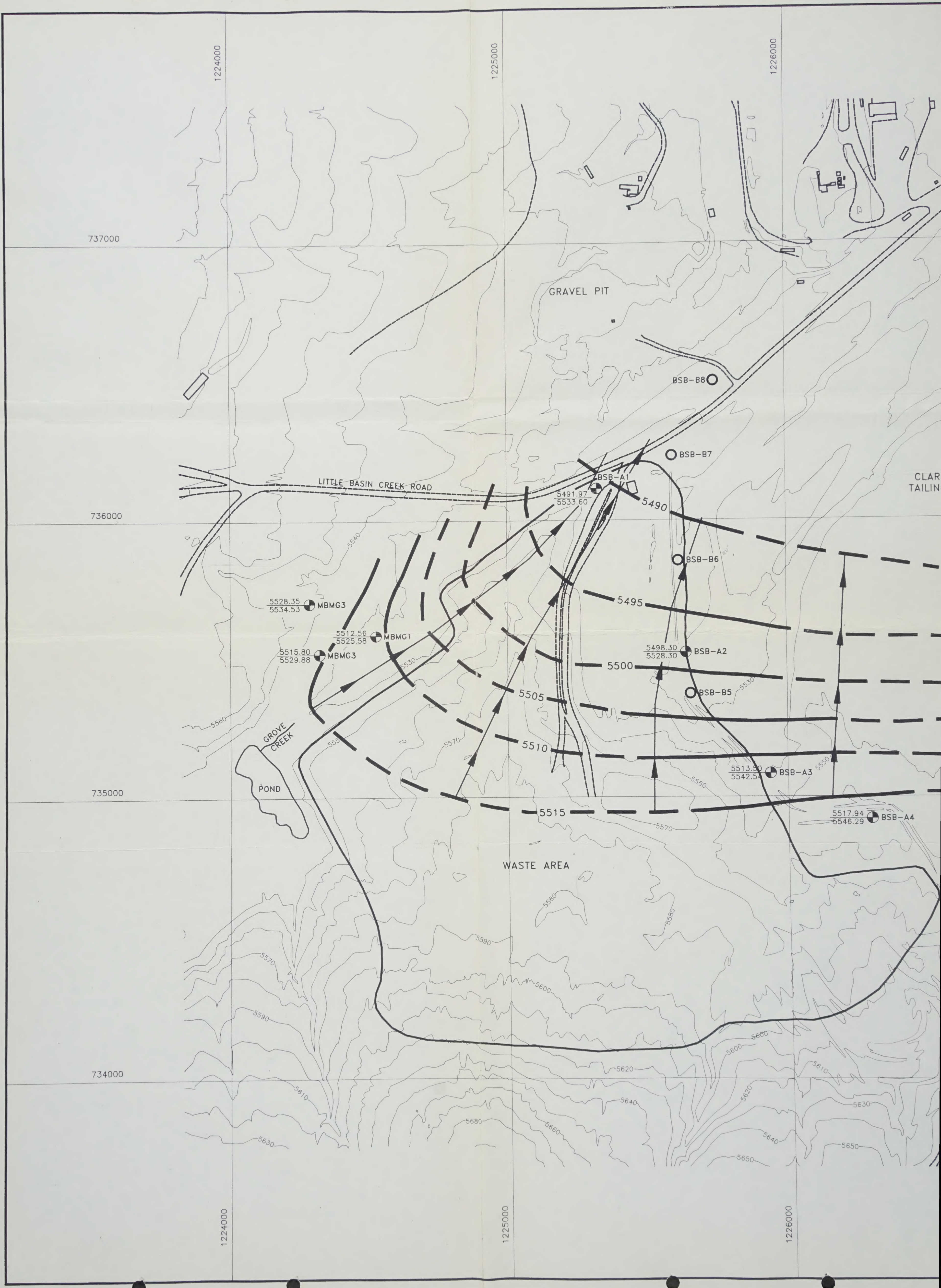
MONITORING WELL LOCATIONS

DRAWN	DESIGNED	APPROVED
WBA/ALW		

SCALE	PROJECT NO.	SIZE	SEQ.	DRAWING
1"=200'	31.00976.02	C		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BSB-A4
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WASTE AREA
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Toll Free: (800) 334-8911
Fax: (406) 782-9968

MEMORANDUM

Date: 4/21/93

To: Pat Potts

Subject: Old Butte Landfill Ground Water Monitoring Plan

Message:

Here is a copy of the ground water monitoring plan for the initial round of sampling.

Dave E

RECEIVED
APR 22 1993
MONTANA DEPARTMENT OF HEALT
AND ENVIRONMENTAL SCIENC

Old butte
lic #20
document

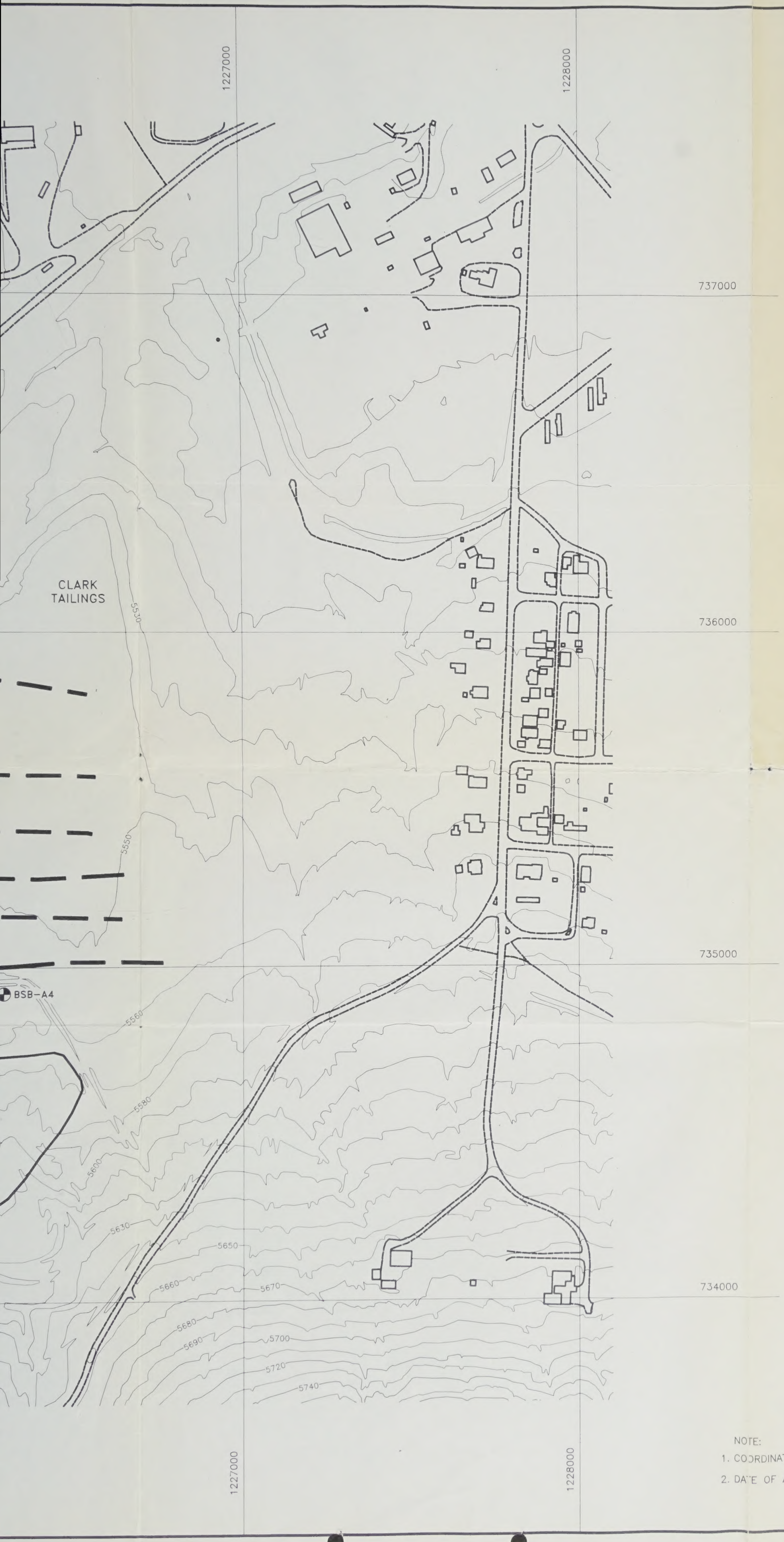
PUT IT IN WRITING
AVOID MISTAKES

Signed

REVISION	DRAFTER	DESIGNED	DATE
0			

W.O.

NEW DRAWING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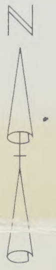

ESTIMATED GROUND WATER CONTOURS

GROUND WATER FLOWPATHS

WASTE FILL BOUNDARY

SWL ELEVATION / TOC ELEVATION ◒ EXISTING WELLS

SWL ELEVATION / TOC ELEVATION ○ PROPOSED WELLS

NOTE:

1. COORDINATES BASED ON NAD27 SO. ZONE

2. DATE OF AERIAL PHOTOGRAPHY – 4/18/89

REFERENCE DRAWINGS	DRAWING NO.

Special Resource Management INC.

BUTTE–SILVER BOW
EXISTING AND PROPOSED
MONITORING WELL LOCATIONS

DRAWN	DESIGNED	APPROVED		
WBA/ALW				
SCALE	PROJECT NO.	SIZE	SEQ.	DRAWING
1"=200'	31.00976.02	C		

Initial Groundwater Monitoring Plan
Butte Silver Bow County Landfill

HHS

1 Ground Water Monitoring Plan / Preliminary SAP, part of 703

The objectives of ground water monitoring at the Butte-Silver Bow Landfill are as follows.

1. Identify background ground water quality.

2. Identify any impacts on ground water quality resulting from landfill activities.

3. Document approved methods to sample and analyze ground water which provide data that are complete, precise, and accurate.

1.1 Sample Collection

Ground water samples will be collected and analyzed for the parameters listed in Table 1.1. Sample collection will be conducted in the following steps.

? lamp for chlor. & CFCs?

LEL
non-
during dil

1. Open well cap and immediately insert the HNu photoionization analyzer to monitor the concentration of VOC's in the well bore.

   what about DNAPLs?

2. Lower an electronic probe to measure the static water level. This probe will have the capability to measure any LNAPL (ok) present. Measurements will be to the nearest 0.01 foot from a reference mark on the top of the PVC well casing and will be recorded in the field log book.

3. Lower a dedicated bailer into the well and purge the well of three well volumes or until dry. Well development records will be maintained according to the Well History Form in Table 1.2.

4. Once the well recovers sufficiently to yield a representative sample, the first sample will be collected, containerized, and field measured for pH, temperature (°C), and specific conductivity (SC). The data from the well purging and the measurement of field parameters will be recorded on the Well History Form in Table 1.2. The other samples will be collected and containerized in the following order.

   1. Volatile organics - 2-40 ml glass bottles.
   2. Water Quality Parameters - 1-500 ml bottle.
   3. Dissolved Metals - 1-250 ml bottle filter with 45 μm filter and preserved with HNO_3.
   4. Cyanide - 1-120 ml bottle with NaOH preservative.
   5. Nitrate, Ammonia, COD, etc - 1-120 ml with H_2SO_4 preservative.

All sample containers will be obtained from Energy Laboratories in Billings. Energy Lab's follow EPA protocol for size of container, material container is composed of, cleaning method for container, and type of preservative. After sample collection is complete, pH,

1 Ground Water Monitoring Plan

Preliminary SAP, part of 703 HHS

The objectives of ground water monitoring at the Butte-Silver Bow Landfill are as follows.

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All sample containers will be obtained from Energy Laboratories in Billings. Energy Lab's follow EPA protocol for size of container, material container is composed of, cleaning method for container, and type of preservative. After sample collection is complete, pH,

temperature, and SC will be measured to check the stability of these parameters during sampling. The full sample containers will be immediately placed in a cooler with a constant temperature of 4 °C.

5. Decontamination will take place before each well is sampled. Equipment to be decontaminated includes the well probe, pH probe, SC probe, and temperature probe. Decontamination will consist of the following steps.

- Alconox scrub
- Tap water rinse
- Distilled water rinse
- Air dry

1.2 Chain-of-Custody Control

The chain-of-custody program will include the following documentation.

1. Sample Labels In order to prevent misidentification of ground water samples collected at the Landfill, the labels will contain the following information.

- Sample ID Number
- Location
- Date and Time of collection
- Preservative
- Samplers Initials

2. Sample Seal During shipment of samples from the site to the analytical laboratory, all sample coolers will be sealed to prevent tampering. The seal will be placed on the container in such a way that the container cannot be opened without breaking the seal.

Table 1.2 Well History Form

Page__of__

WELL HISTORY FORM

Well name:____________________ Location:____________________
Project name:______________ No:______________Task:___________
Well elevation:______________ Well Depth:____________________
Ground Elevation:____
Date Installed:________________ Screen Interval:_______________

DEVELOPMENT DATA

Date	Time	Water Level	Elev.	Well Vol.	pH	Temp. F	S.C.	Comments

3. Field Logbook A field logbook will be on-site during all sampling and will contain the following information.

- Identification of well
- Well depth
- HNu reading
- Static water level — LNAPL thickness
  DNAPL "
- Well Volume
- Purge volume, pumping rate, & start and end time
- Date and time of sample collection
- Sample ID numbers
- Field analysis data (pH, SC, Temp.)
- Samplers Name
- Field observations

4. Chain-of-Custody Record In order to trace the possession of a sample from the field collection to the analysis, a chain-of-custody form will be completed with the following information.

- Sample number
- Signature of all parties handling the sample
- Date of all Signatures
- Date & Time of collection
- Sample type
- Number of containers
- Sample analysis request
- Condition of container upon arrival at laboratory

1.3 Analytical Procedures

The EPA analytical procedures summarized in Table 1.3 will be used for the analysis of the ground water samples.

Table 1.3 Analytical Procedures
MDHES Table 1 Parameters

Parameter	EPA Method	Detection Limit(mg/l)
Water Quality		
Ammonia	350.1	0.1
Bicarbonate	310.1	1
Calcium	200.7	1
Chloride	300.0	1
Iron	200.7	0.03
Magnesium	200.7	1
Manganese	200.7	0.02
Nitrate	353.2	0.05
Potassium	200.7	1
Sodium	200.7	1
Sulfate	300.0	1
COD	410.1	1
TDS	160.1	1
TSS	160.2	2
pH	150.1	0.01 STD units
Metals		
Arsenic	200.7	0.005
Barium	200.7	0.1
Cadmium	200.7	0.001
Chromium	200.7	0.02
Cyanide	335.3	0.005
Lead	239.2/200.7	0.01
Mercury	245.2	0.001
Selenium	270.3	0.005
Silver	200.7	0.005
Volatile Organic Compounds		
VOC	8260 (long list)	Dependant upon matrix

1.4 Field and Laboratory Quality Assurance/Quality Control

A quick summary of the samples for Quality Control is provided below.

Trip blanks -	One trip blank will accompany the sample cooler from the laboratory to the field and back to the laboratory for each sample event
Duplicate -	One duplicate sample will be collected per sample event. The type of analysis for the duplicate will vary for each sample round and the analysis will not be the same as the analysis of the equipment Blank.

Energy will follow the QA/QC procedures outlined in their plan for all sample analysis.

1.5 Data Management and Statistical Analysis

All analytical data generated during the landfill monitoring will be stored in the GRITS/STAT database software program. This will allow easy access to all information. Hardcopies of laboratory reports will be kept on file for cross reference. The data will be organized in one file with columns labelled as follows;

Well ID, Date, Time, Gallons Purged, pH, Temp, SC, and all parameters sampled.

In order to specify statistical method that will be used to analyze the ground water constituent concentration (GWCC), it is very important to have at least four data points for each parameter sampled. Since the data are not available at this time, the following table summarizes the statistical method that will be used and the conditions under which it will be used. Different methods will be used for the different parameters that will be sampled.

Table 1.5 Summary of Statistical Analysis of GWCC

COMPOUND	**TYPE OF COMPARISON**	**STATISTICAL METHOD**
DETECTION MONITORING		
Compound with background concentration	Background VS Compliance	ANOVA until >4 data points, then Tolerance Limits
Synthetic compound	Nondetects in data set	<15% - ANOVA and Tolerance Limits (parameteric). Nondetects will be replaced with MDL/2 15%-50% - ANOVA and Tolerance Limits with adjustments (Cohens, Winsorizing, etc.) >50% - Test of proportions
COMPLIANCE MONITORING		
ACL/MCL Specific	Fixed Standards	Tolerance limit (95%)

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Fax: (406) 782-9968

Form No. 0074

MEMORANDUM

Date: 2-8-93

To: Pat Crowley
Solid & Hazardous Waste Bureau

Subject: Old Butte Silver Bow Landfill - Existing Cover

Message:

As discussed with you on the telephone SRM and Butte-Silver Bow would like to modify the drilling program we proposed on January 18, 1993 for the old landfill. We originally proposed drilling through the existing cover on a 100-foot by 100-foot grid pattern. We would like to modify that to a 200-foot by 200-foot grid pattern with selective borings at smaller spacings, i.e. around the boundary. This altered pattern with selective borings should give SRM enough information on the amount (depth) of cover existing.

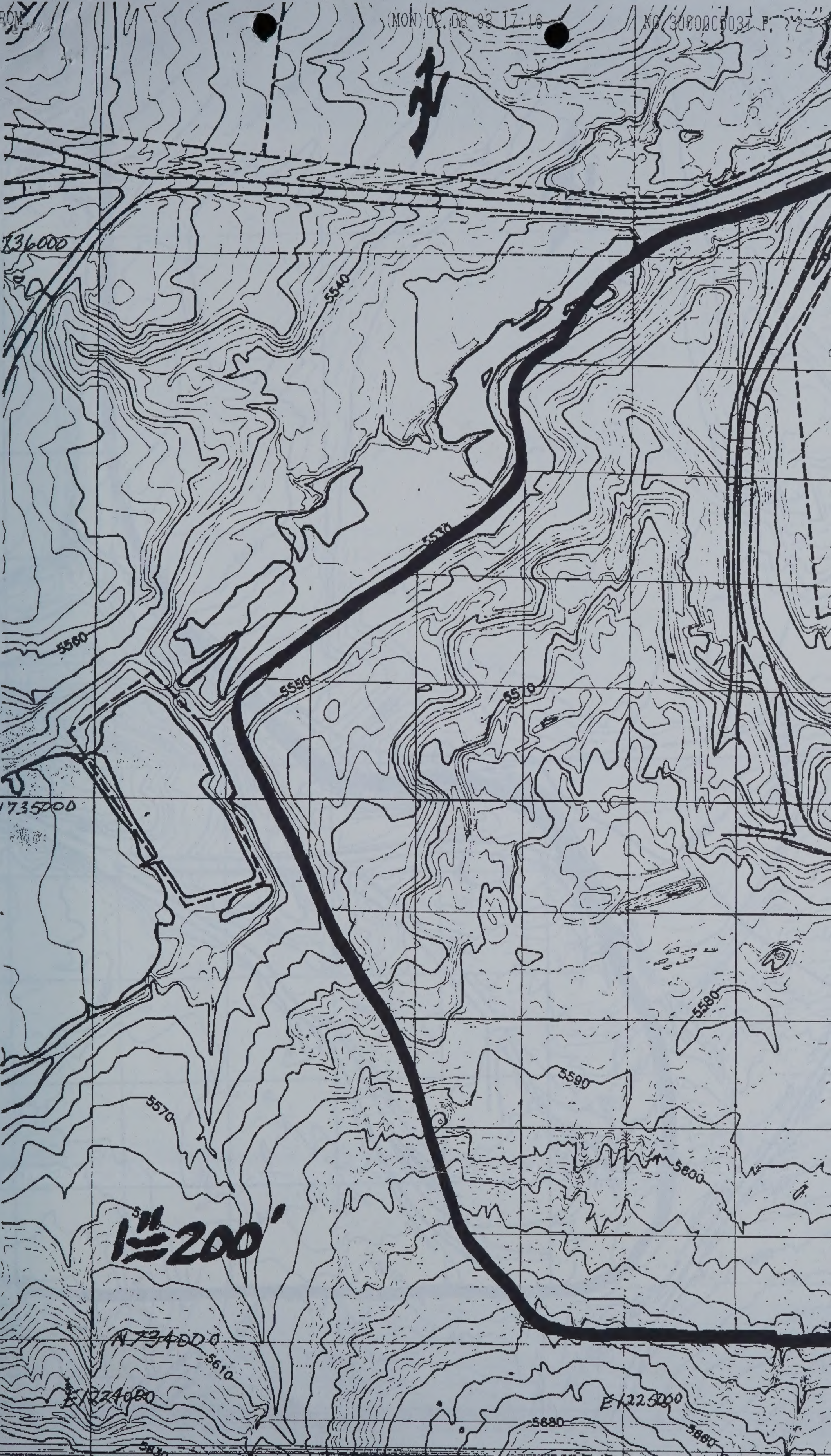
If you have any questions regarding this request please call me at 782-4201.

RECEIVED
FEB 08 1993
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

DESIGN PRINTING (406) 443-1054

PUT IT IN WRITING
AVOID MISTAKES

Signed Jason T. [illegible]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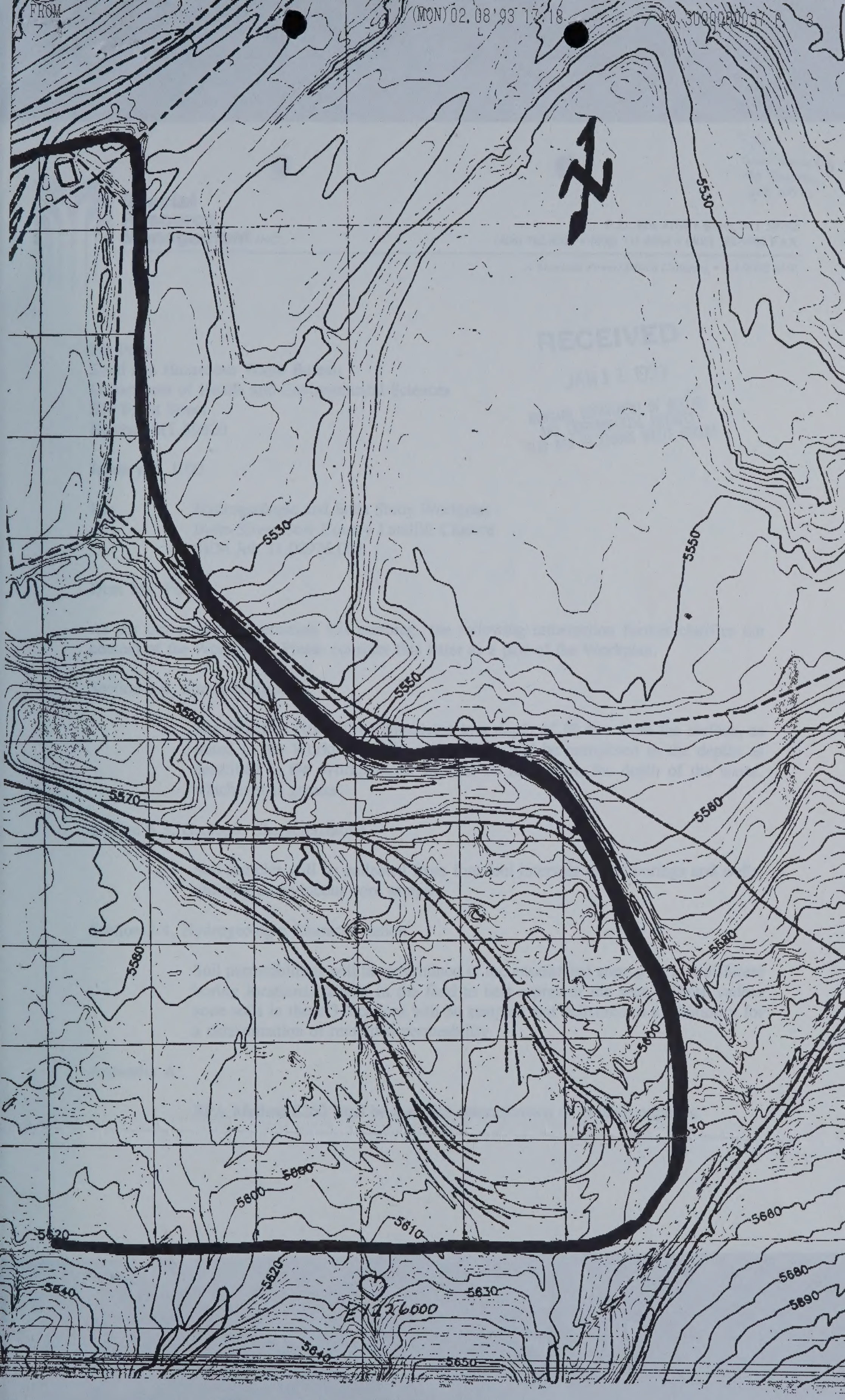
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File:
Silver Bow Co,
old Butte,
grd wtr.

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JAN 11 1993
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

Pat Potts
Solid and Hazardous Waste Bureau
Department of Health and Environmental Sciences
836 Front Street
Helena, MT 59620

January 7, 1993

Re: Hydrogeologic and Soils Study Workplan
Butte-Silver Bow County Landfill Closure
SRM Job 31.00976.002

Dear Ms. Potts:

As per our phone conversation this morning, the following information further clarifies the content of the Workplan. Please consider this letter as a part of the Workplan.

Section 3.0, Site Investigation

The Backhoe pits will be completed to a depth of 10 feet from the surface, as stated in the Workplan. The soil borings will be completed to the depths as described in the Workplan, or at least 20 feet below the depth of the waste, whichever is greater.

Section 3.3, Geologic Characterization

Soil samples will be collected from five foot intervals on all borings and wells, utilizing a continuous core sampler.

Section 3.4, Hydrogeologic Characterization

Soil permeabilities will be determined in the unsaturated zone soils at 3 different boring locations, chosen in the field to best represent the area. These vadose zone soils in these 3 locations will be sampled and delivered to a laboratory for a determination of remolded permeability.

Appendix A

EPA Method 8260 shall be used for determination of volatile organics.

If there are any questions or concerns beyond the above clarifications, please contact me as soon as possible. We look forward to your approval of the Workplan, as clarified above, so that our client, Butte-Silver Bow County, may proceed with these activities.

Thank you for your consideration.

Sincerely,

Edward L Handl

Edward L. Handl, P.E.
Manager, Technical Services

Copy: Mike Shea/James Johnston
Public Works Department
Butte-Silver Bow Courthouse
Butte, MT 59701

Special Resource Management INC.

(406) 782-4201 •

A Montana

Pat C PRC
Jim W JW
P3 P3

December 22, 1992

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AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

Pat Potts
MDHES-Solid Waste Program
Cogswell Building
Helena, MT 59620

RE: Butte-Silver Bow Landfill, Silver Bow County - License No. 20, Revised Work Plan for Hydrogeologic and Soils Study, Revision 2, Butte Silver Bow County Landfill Closure.

Dear Pat,

Please find enclosed for your review two (2) copies of the "Work Plan for Hydrogeologic and Soils Study, Revision 2, Butte-Silver Bow County Landfill Closure". As directed in your letter dated December 6, 1992, the work plan was revised to incorporate your comments.

If you have any additional questions or comments, please direct them to Mr. Ed Handl of SRM or Mr. James Johnston at the Butte Silver Bow Public Works Department.

Sincerely,

David J. Erickson
Hydrogeologist

CC: Mike Shea/ Jim Johnston
Public Works Department

Special Resource Management INC.

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December 22, 1992

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AND ENVIRONMENTAL SCIENCES
SOLID AND HAZARDOUS WASTE BUREAU

Pat Potts
MDHES-Solid Waste Program
Cogswell Building
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Hydrogeologist

CC: Mike Shea/ Jim Johnston
Public Works Department

Pat C PRC
Jim W JW
P3 p3